MARINE ENGINEERING.

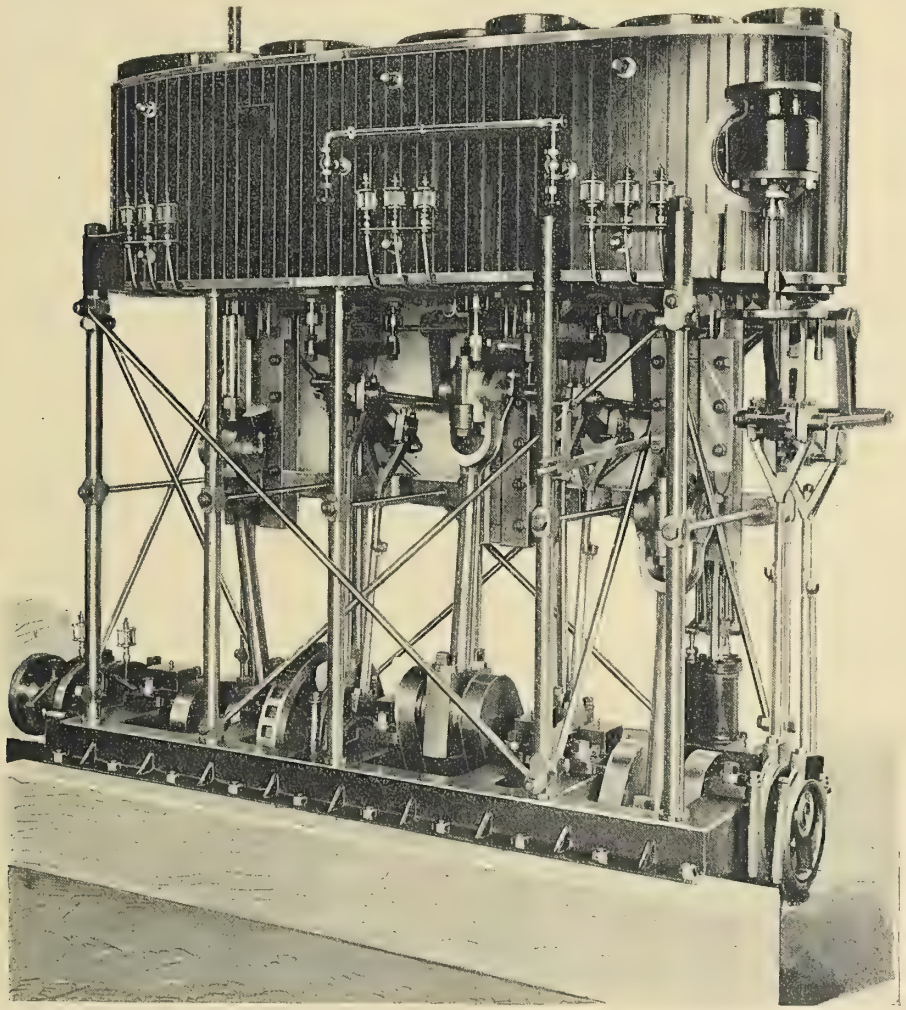
Vol. 2. NEW YORK, SEPTEMBER, 1898. No. 9.

D.S.E.

MODERN TYPE OF VERTICAL-INVERTED TRIPLE-EXPANSION MARINE ENGINE.

We here show an illustration of an extremely handsome high-class triple-expansion marine engine of a type which is largely being turned out now for small vessels. This particular engine represents a standard type adopted by the Fore River Engine Co., of Weymouth, Mass. It has cylinders 9 in., 14 1-4 in., and 23 1-2 in. dia. by 14 in. stroke.

The cylinders with their valve chests and receivers, are of hard close grained cast iron, each cylinder with its valve chest being cast separately, and securely bolted together.



MODERN TYPE OF TRIPLE-EXPANSION MARINE ENGINE.

Copyright, 1898, by The Marine Publishing Co., New York.

The stanchions or frames supporting the cylinders are of open hearth machinery steel, accurately turned to fit reamed holes in the cylinder lugs and bed plate. All frame holes in the cylinders and bed plates are drilled through a jig, enabling duplications of these parts at any time, and also ensuring perfect alignment when the engine is erected. The crankshaft is of open hearth machinery steel of the built up type, this being one of the special features of the Fore River engine. After all parts of the crankshaft are completely finished, it is put together, and trued up simultaneously, to a perfect alignment, and in no instance are the shafts or pins returned.

Connecting rods, piston rods, links, eccentric rods, cross and diagonal braces are of open hearth steel and highly finished. All bearings are lined with special white metal, adapted for use in crankshaft and crankpin bearings.

The pistons are of cast steel with followers and cast iron spring rings. All the valves are of the piston type, one for the high pressure, two for the intermediate and two for the low pressure cylinders. The valves are actuated by Stephenson link-motion valve gear with links of the double bar type, having all wearing parts adjustable. The valve stem guides are arranged with adjustable gibs having large wearing surfaces.

The crossheads are of the slipper type of cast bronze with large wearing surfaces. The crosshead guides are of cast iron and arranged for water circulation.

The engine is handled by a steam reversing gear having steam and oil cylinders, with operating handles on the front of the engine. There is a complete system of oiling enabling all the running parts to be supplied with oil when the engine is in motion.

The thrust bearing is attached to the after end of the engine bed in such a manner that constant alignment is assured.

The bracing is of the most efficient form and all parts of the engine are easily accessible for adjustment or repair.

The Holland-America Line's new twin-screw steamer Statendam, built by Harland & Wolff, at Belfast, arrived at Rotterdam from Belfast late last month. On the passage the engines worked very smoothly, and a speed of 16 1-2 knots was attained. The Statendam is 530 ft. long, 60 ft. beam, and 43.6 ft.. deep, giving her a gross tonnage of nearly 11,000 tons. In addition to the steamer's large cargo capacity she has accommodation for 200 first-class, 150 second-class, and a large number of steerage passengers. The Statendam is the second of five new twin-screw steamers, which the Holland-America Line is building for a weekly passenger and freight service. The Rotterdam was the first of the new steamers.

MARINE GASOLINE AND GAS ENGINES AS USED IN MODERN MOTOR BOATS.—III.

BY CECIL H. PEABODY, M.E.

Having inquired into the general principles and methods of running gasoline engines, let us now consider their application to propelling boats and launches. Anyone who has experienced the delay in getting up steam on a steam launch and seen the engineer watching the steam gauge and feeding the fire, can understand at once the advantage of a motor which can start at full power at a moment's notice and which has no boiler or furnace. The absence of a boiler leads incidentally to an advantage of great importance for small boats in that no engineer's license is required.

There seems also to be greater control over the location of the engine in the boat; for very small boats there is a great advantage in placing the engine right aft, and thus leaving the body of the boat for the passengers. This is well illustrated in Fig. 6, which shows very distinctly the longitudinal section of a 16-ft. launch built by the Racine Boat Manufacturing Company, and fitted with a one horse-power motor which is expected to give a speed of 5 1-2 or 6 miles an hour. Fig. 7 gives the general appearance of a 20-ft. launch, which, however, differs only in size and in minor details.

The engine in the example illustrated is placed right aft, so that there is a very short propeller-shaft, and the exhaust from the engine, after passing through a muffler, is turned under the counter so that it causes no inconvenience to the passengers. The engine has an electric ignition with the batteries in a box just forward of the engine. Since the engine with a single cylinder can have only one working stroke for two revolutions, it has a heavy fly-wheel. The engine always runs in one direction and the boat is reversed by turning the blades of the propeller, as will be explained later. Of course, gasoline engines may be used on much larger boats; for example: Fig. 8 represents a 53-ft. twin screw yacht built by the Daimler Motor Company. Gasoline engines appear to be exceedingly well adapted for auxiliary power on sailing yachts and vessels, since they may occupy but little space and do not interfere with the working of the vessel under sail. To show that such engines may be used for business as well as for pleasure, an illustration (Fig. 9) is given of a New Zealand schooner fitted with a 20 horse power engine made by the Union Gas Engine Company of San Francisco.

It is imperative that the power for a boat shall always be available. This is true for a steam engine so long as there is pressure in the boiler, for the engine may be started promptly by letting on the steam. On the other hand, there is a certain amount of manipulation required to start a gasoline engine. First the vaporizer must be charged by hand and then the engine must be turned around to draw in and compress a charge of ex-

plosive mixture, which is ignited in regular order by the igniter, upon which the engine should start running. The time required for this appears short at the dock or landing when the boat is made ready for a trip, but it might be long enough to lead to serious consequences if the boat were maneuvered by starting, stopping and reversing the engine. Consequently it is customary to allow the engine to run continuously so long as the boat is in service. Some method must be provided for reversing the power of the engine, and though it is not absolutely necessary, it is advisa-

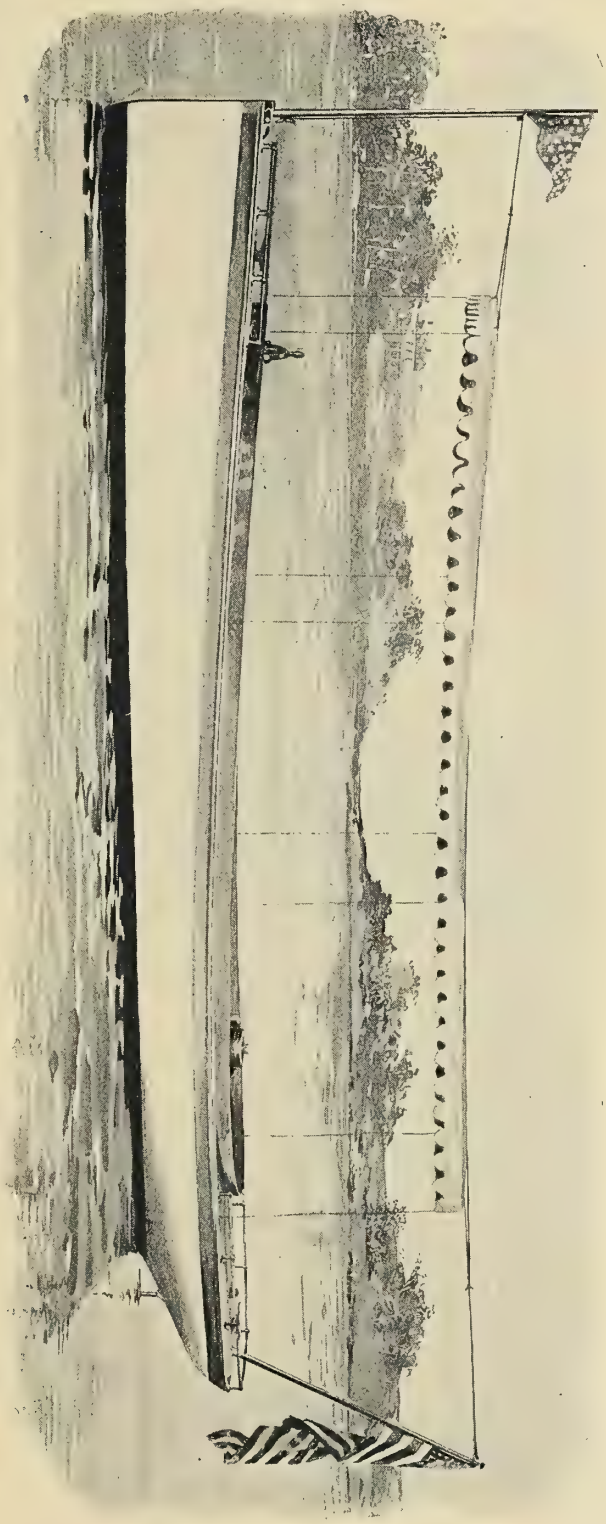


FIG. 7.—25-FT. LAUNCH BUILT BY THE RACINE BOAT MANUFACTURING CO.

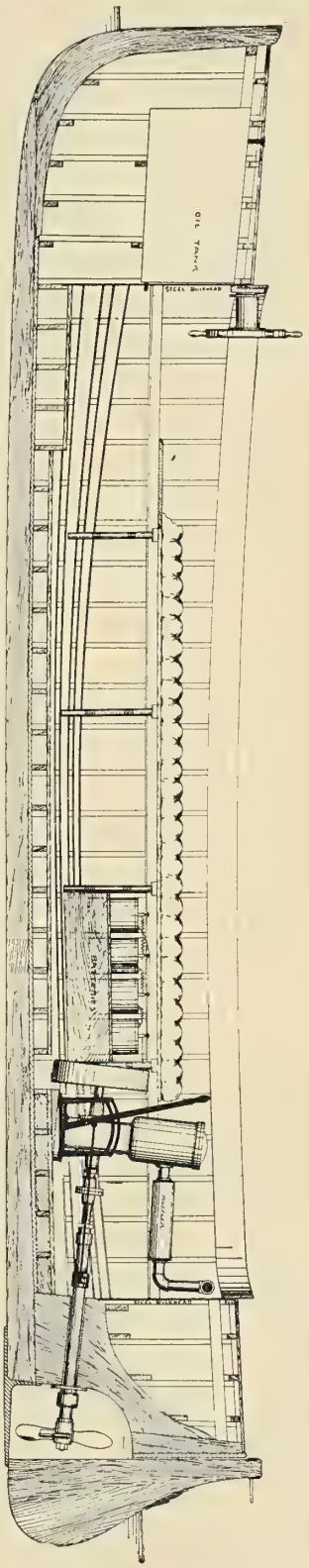


FIG. 6.—LONGITUDINAL SECTION 16-FT. LAUNCH, WITH 1 H. P. MOTOR.

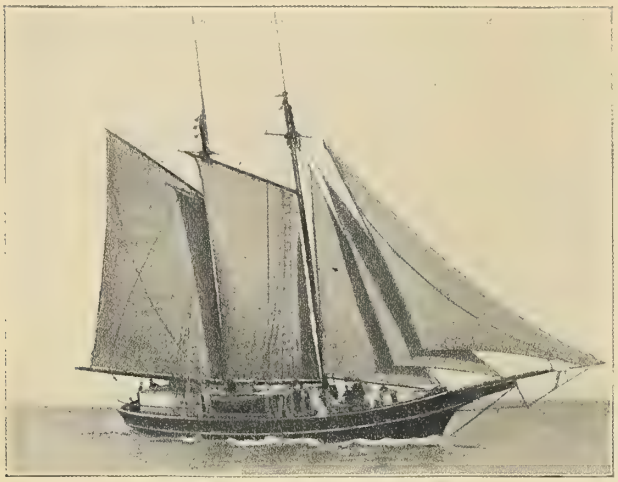


FIG. 9.—NEW ZEALAND SCHOONER.

ble to apply a governor to control the engine when it is running idle or with small power.

There are two ways of reversing in common use; one makes use of some form of gearing to reverse the propeller-shaft, and the other depends upon turning the propeller blades.

Fig. 10 shows the reversing-gear used by the Van Duzen gasoline engine. The main-shaft of the engine carries two spur-wheels, either of which can be made to revolve with the shaft by a clutch which is worked by a vertical lever. The spur-wheel near the engine gears directly with another spur-wheel of the same size on the propeller-shaft below, so that when the lever is thrown forward the boat is driven ahead. When the lever is in the middle position, as shown in the figure, the engine is disconnected from the propeller-shaft and runs freely under the control of the governor. To make the boat go astern the lever is thrown back, and it clamps the other spur-wheel to the main-shaft of the engine. This spur-wheel does not act directly on the corresponding wheel on the propeller-shaft, but it drives it through an idle-wheel on a stud of which the end only can be seen in the figure; the idle-wheel itself is hidden by the standard, which carries the stud and the bearings for the main-shaft and the engine-shaft. When this three-wheel gear is in train the propeller-shaft is reversed and the boat is driven astern while the engine runs in the usual way for driving the boat ahead. The clutches shown in Fig. 10 are clearly friction clutches, as they ought to be, so that the propeller shaft may be started in either direction, gently and without any shock to the machinery.

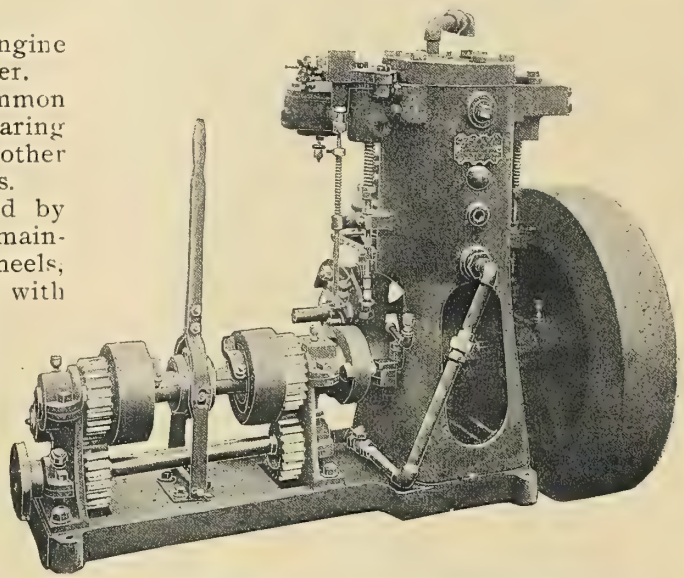


FIG. 10.—VAN DUZEN MARINE ENGINE.

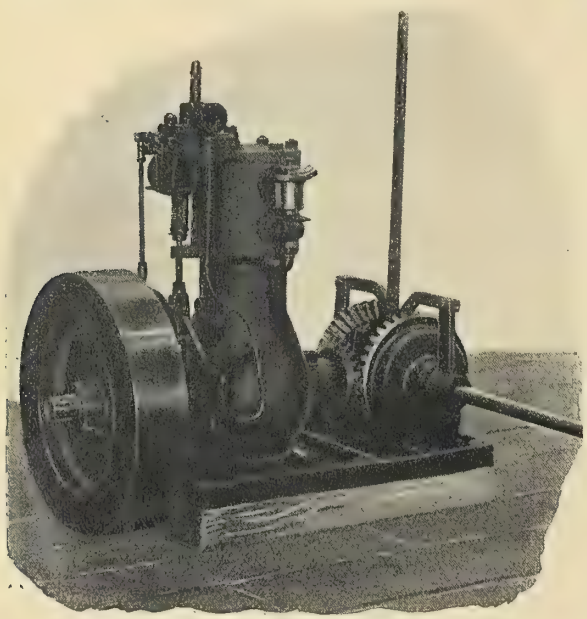


FIG. 11.—4 H. P. WOLVERINE MOTOR.

Another method of accomplishing the same object by the aid of a train of bevel gears is shown in the engraving of a 4 horse power engine built by the Wolverine Motor Works (Fig. 11). Here the engine-shaft carries a bevel wheel which gears with two bevel wheels on a transverse shaft. The two wheels are both loose on the transverse shaft, but either can be clamped to it by a friction clutch that can be thrown by the hand lever which moves transversely. The gear represented in the figure is used by the Wolverine Motor Works for a stern-wheel boat, the paddle-wheel being driven from the transverse shaft by a chain running on sprocket wheels. If such a gear is used for a propeller it may be arranged as shown by Fig. 12, where A is a bevel wheel on the engine-shaft and B is another on the propeller-shaft. C is a bevel wheel set in a disk, or wheel which has a rim *d e* running in a brake-band. In the figure the cylindrical axle on which the wheel turns is represented as carried directly across the brake-wheel. The

hub *f* of the brake-wheel runs on the ends of the engine-shaft and of the propeller-shaft. If the brake-band is drawn back so that it does not touch the brake-wheel the whole mechanism will revolve together, and the boat will be driven forward as though the main-shaft and the propeller-shaft were continuous. But if the brake-wheel is held fast so that it cannot turn, the wheel C will revolve on the transverse shaft, and the wheel B will turn in the opposite direction from A, driving the boat astern. Fig. 12 is intended to give only the general principle of the device, and in practice it will be constructed with different details as required, either for economical construction or durability in service. It is probable that the friction of the wheel C on its its bearing will be enough to keep it from turning when the brake-band is drawn back, but if necessary a friction clutch can be arranged to act when the boat is going ahead, and to be released when going astern, which clutch shall clamp the wheel C to its shaft.

The Daimler Motor Company uses a train of friction cones for running, as is shown by Fig. 13 When the boat is going ahead the small or middle cone is drawn back out of gear and a friction clutch locks the engine-shaft and the propeller-shaft together. When going astern the two shafts are released so that they can turn in opposite directions, and the middle cone is forced up against the two larger cones to drive the propeller in the proper direction to back the boat.

Of the three methods illustrated by Figs. 10, 11 and 13 it is difficult to say which will be most satisfactory, as much depends on the workmanship and the condition of the gear, especially when friction is depended upon for working clutches or for direct driving, as in the last case. Fig. 10 shows the cheaper device, for spur gears are less expensive than bevel wheels or friction cones. The arrangement of bevel gears indicated by Fig. 11 will call for exact and sound workmanship if good re-

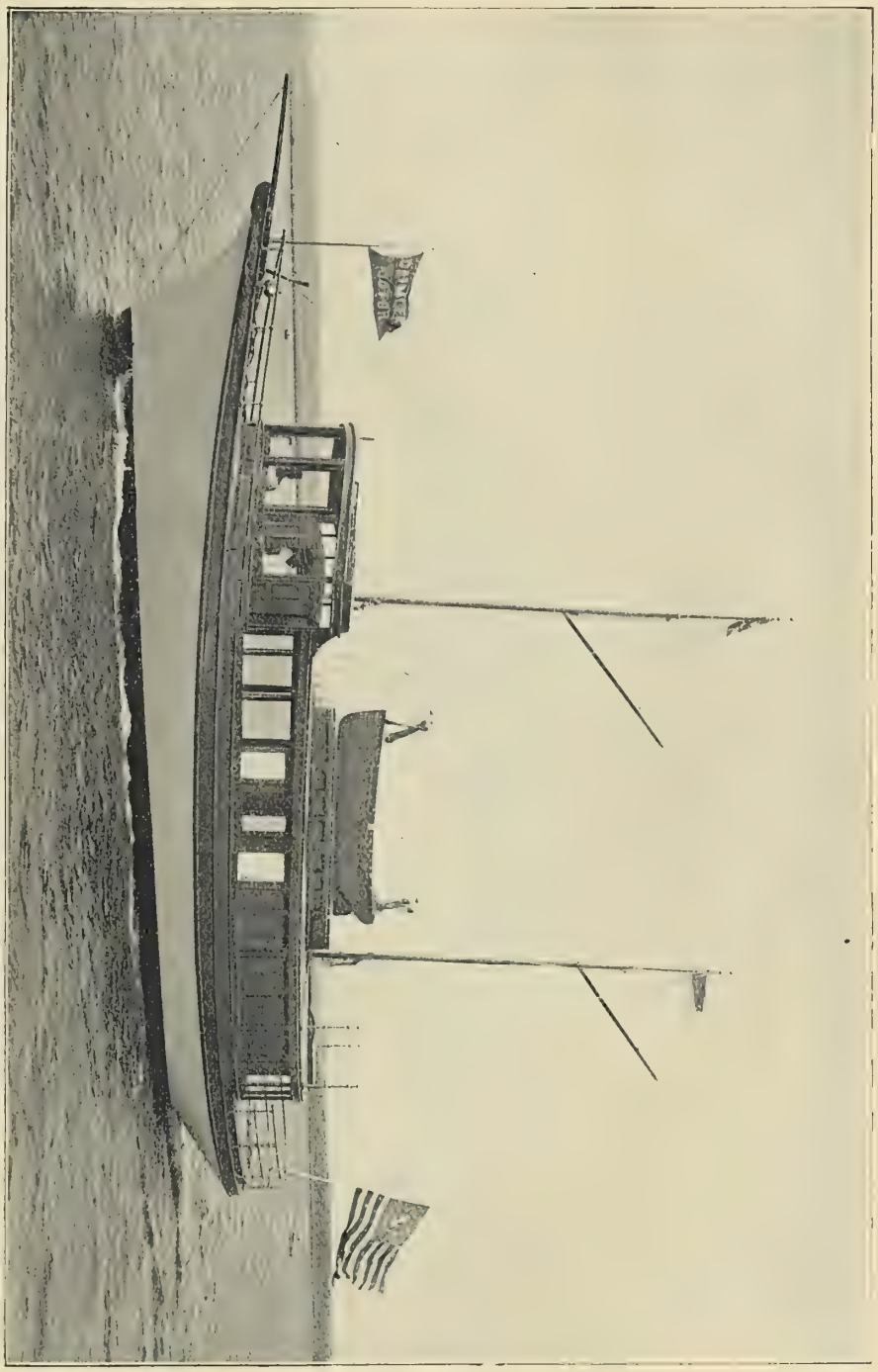


FIG. 8.—53-FT. TWIN SCREW YACHT BUILT BY DAIMLER MOTOR CO.

sults are expected. It appears to be the neatest, and has the advantage that the gear wheels are not in service when the boat is going ahead. The friction cones shown by Fig. 13 are also out of service in going ahead, and this is probably essential to their proper action since friction wheels

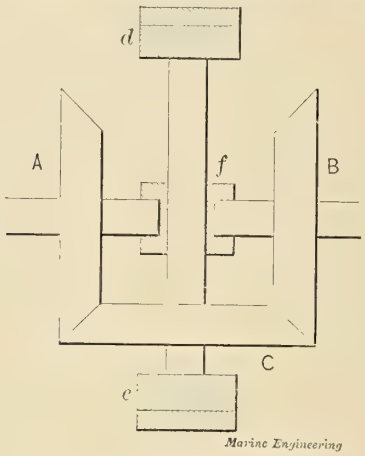


FIG. 12.—REVERSING GEAR.

cannot be expected to do continuous hard work.

The simplest and most compact way of reversing without stopping or changing the direction of rotation of the engine is to twist the propeller blades. Now, twisting propeller blades is a very

sistance or drag of the propeller. The Bevis propeller (Fig. 14) had a large spherical hub with separate blades. Each blade could turn in its seat in the hub and was provided with a crank inside the hub. The propeller-shaft was hollow and through it ran a rod which was connected to

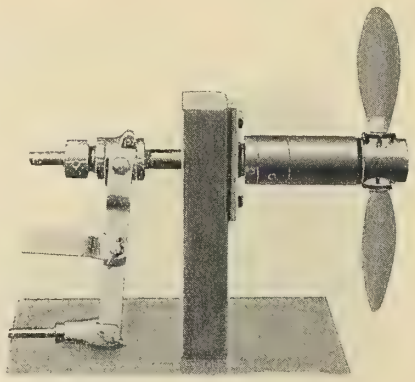


FIG. 15.—REVERSING PROPELLER.

the cranks on the propeller blades. When this rod was forced in one direction it turned the blades into the normal position for driving the ship; when it was forced in the other direction it turned the blades fore and aft so that they offered

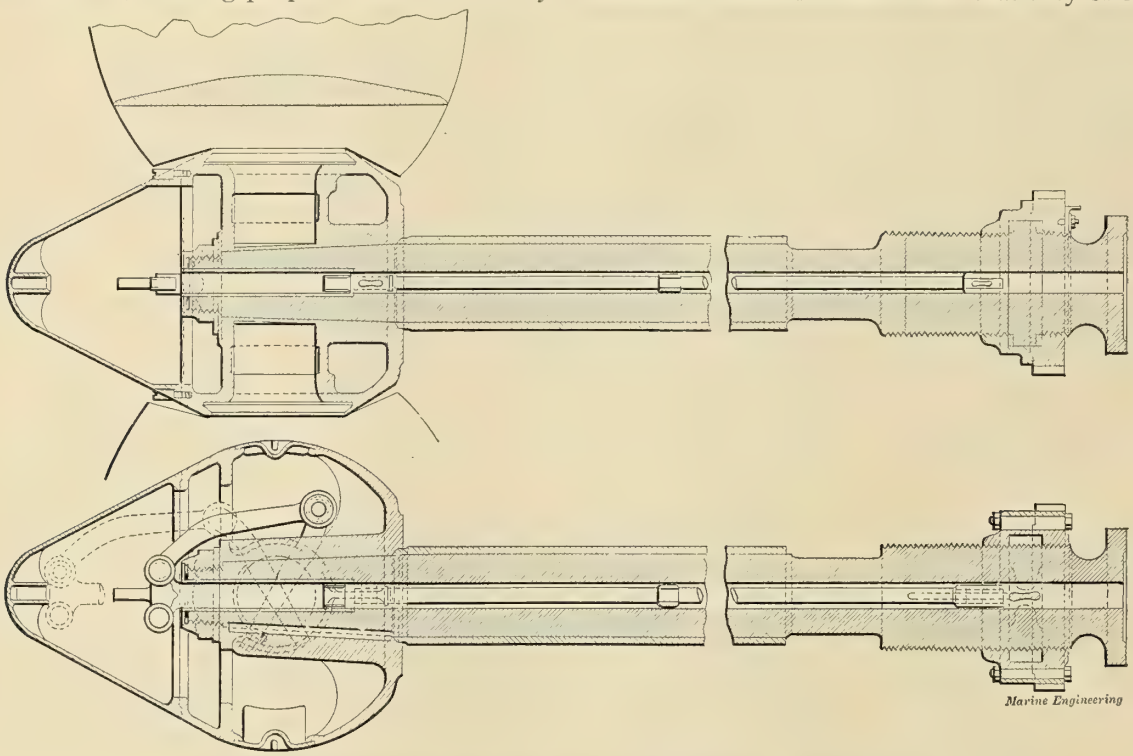


FIG. 14.—CONSTRUCTION OF BEVIS FEATHERING PROPELLER.

old device, invented under the name of feathering propellers for sailing ships with auxiliary steam power. They were primarily intended to turn the blades of the propeller fore and aft when the ship was under sail only, and so minimize the re-

but little resistance to the water. Of course, the blades could also be twisted part way and so alter the pitch of the propeller wheel; but that was a secondary consideration. The inner end of the rod was attached to a cross-yoke that moved in a

slot cut right through the shaft, and this yoke could be moved by aid of a grooved collar that rotated with the shaft. A lever working in the groove of the collar provided a way for moving back or forth the collar, yoke and rod, and thus turning the blades of the propeller while the engine was turning. It is evident that so complicated a device could not be used when much power was transmitted, so the feathering propeller has passed out of service and is not now used even on yachts which depend both on steam and sail.

The feathering propeller has, however, been adopted as a means of reversing gasoline launches, and mechanically is well adapted to the purpose, as it is simple and can readily be made strong enough for the small power required by a launch. Fig. 15 represents the reversing propeller made by the Grand Rapids Gas Engine and Yacht Company. The figure is clearly for illustration and represents the stern part of a boat with the bearing for the propeller-shaft. The shaft has a collar that can be moved back and forth and out upon a rod inside the shaft. The propeller blades can turn and are moved by the rod which acts on cranks inside the hub. The details are not shown by the figure; it is to be regretted that the makers of gasoline engines have not yet arrived at the place where they can exhibit details of their machines more freely.

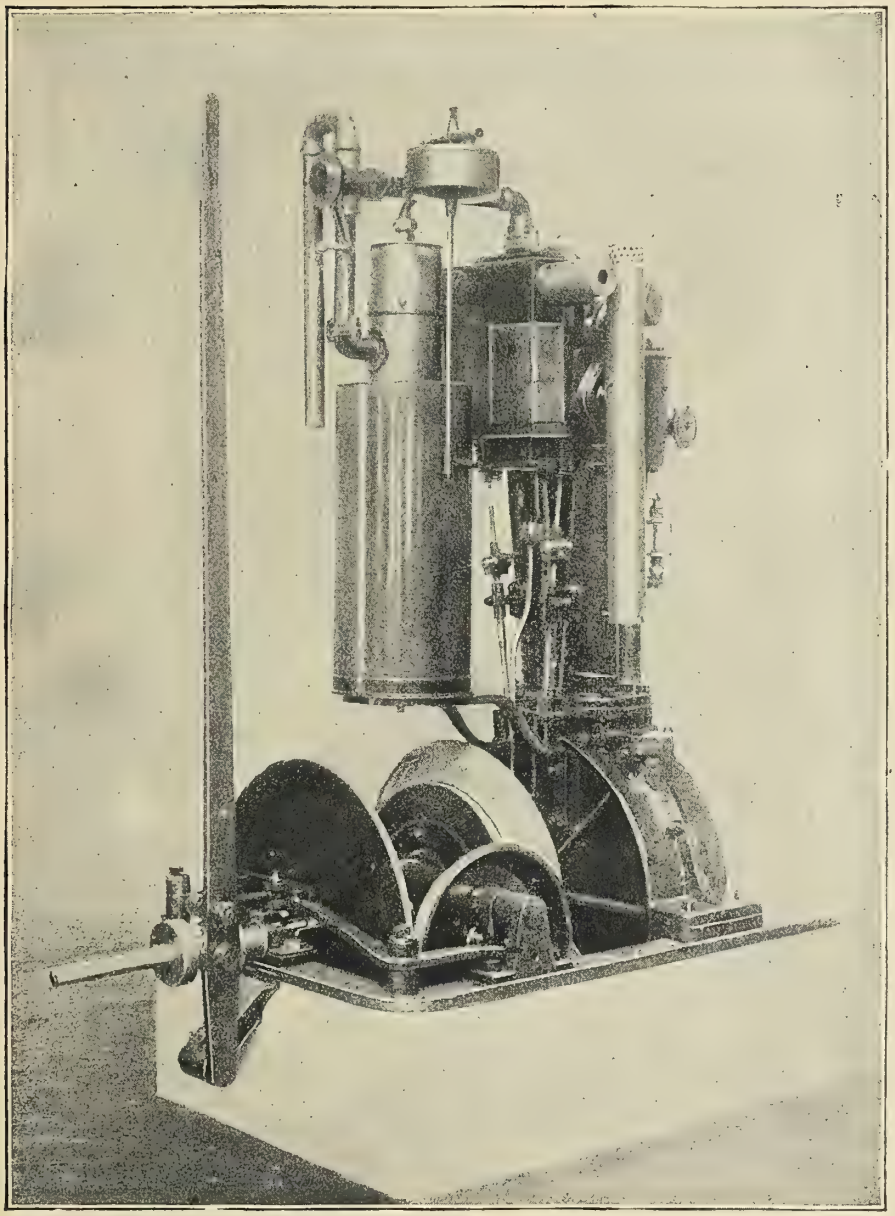


FIG. 13.—DAIMLER MOTOR WITH REVERSING GEAR.

In considering the action of a reversing propeller it must be remembered that the propeller blade has, or should have, a true mathematical surface like that of the thread of a screw. Now a right-handed screw is essentially different from a left-handed screw, and a part of the surface of the right-handed screw —no matter how small it may be — cannot be made to fit a left-handed screw. If the reversing propeller was intended to work equally well in either direction its blades ought to be flat; but such a propeller would lose half of its efficiency as compared with one having properly shaped blades. Reversing propellers are, in fact, made with the blades properly shaped for going ahead, and, when twisted around to go astern they are less than half as efficient as when going ahead. But any screw-propeller is less efficient when backing than when going ahead because it is then at the wrong end of the boat and is unfavorably affected by the rudder. Consequently we may expect to find that a reversing propeller is very inefficient when backing. This is of less importance for a light boat that can be fended off,

but is a great inconvenience, if not a danger, for a large boat.

It is probable that either a reversing gear or a reversing propeller will work well enough for a small boat. For a large boat it appears advisable to be able to reverse the engine. The Wolverine Motor Works make an engine which can be reversed while running and without turning it by hand, as represented by Fig. 16, with the flywheel removed for showing the running-lever. This engine has two cylinders and has an explosion in each cylinder for each revolution, the explosive mixture being lightly compressed in the crank end before being introduced in the cylinder, as described in Fig. 3 of the previous article in the August number of MARINE ENGINEERING. By this method the engine becomes equivalent to a single-acting steam engine, and two cylinders are equivalent to an ordinary double-acting steam engine. It can hardly be considered that two cylinders will avoid stopping occasionally on a dead center, though that may not be very important for a small engine. Some of these engines have three cylinders, and are equivalent to a three-cylinder single-acting steam engine, and may be expected to start promptly when arranged with their cranks at 120 deg. It is interesting to note that six cylinders would be required to give a like effect if each cylinder has only one explosion in two revolutions, as has been found most advisable for gas engines. If gasoline or any form of gas engine is ever used for large ships, there will be little trouble in providing a sufficient number of cylinders for smooth running.

Thus far we have considered only gas engines or gasoline engines, and the latter differ from the other only in that the combustible gas is made as it is used. In order that this can be done easily, a volatile fluid like gasoline is chosen. It must be remembered that a volatile liquid like gasoline vaporizes freely at the ordinary temperature of the atmosphere. If any of it is spilled it quickly dries off, and a little vaporizing on the hand gives a decided sensation of cold. It is absolutely essential that great care should be taken in using gasoline or naptha, as they readily form explosive mixtures with air and the slightest spark may be enough to ignite the mixture if it happens to be of the right proportions. If a saturated mixture of naptha and air at the pressure of the atmosphere is exploded in a closed receptable a pressure of ninety pounds to the square inch can readily be attained. If the mixture contains more air than is necessary for combustion, the explosion will be less severe, and again, if the space is partly open or has but slight walls the pressure will be less. But in any case an explosion may be expected to give disastrous results. The writer has known a bad explosion to occur in an open boat house from naptha that had been spilled on the surface of the water.

It may consequently be considered that when gasoline is used in a confined engine room great care should be taken to make and keep all connections of the supply pipe absolutely tight, and that the first appearance of an odor of gasoline should

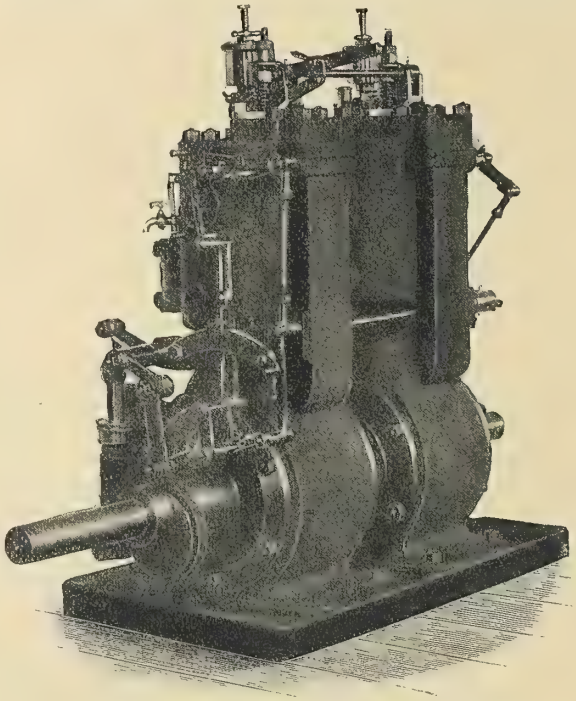


FIG. 16.—WOLVERINE REVERSING MOTOR.

call first for complete ventilation and extinction of fires and lights of all kinds, and second, for necessary repairs and adjustments. It is to be remembered, also, that it is the vapor and not the liquid that is dangerous; for example, an empty can is more dangerous than a full one. Open boats are, of course, little liable to danger of explosions, though the gasoline, if spilled, may take fire and burn.

Insurance companies in America and the government in England interfere with the storing and use of gasoline and naphtha, and so have checked their use in gas engines, especially for stationary purposes. Much attention has been given in England to the development of engines that can use refined or safe oils like kerosene. The difficulty in the use of such oils is that they cannot be completely vaporized by the application of heat alone. If a vessel containing kerosene is heated gently the fluid will begin to boil, and the vapor passing off may be caught in a condenser and liquefied. This distillate is lighter than the original oil, and the oil remaining in the vaporizing vessel is heavier. If the temperature is raised, more and heavier oil will pass off, and thus the oil may be separated by fractional distillation. There will, however, always be a remnant that will not vaporize but will finally break up if the temperature is raised high enough, giving a lighter oil and a tarry product. The last operation is a destructive distillation. It appears at first very

remarkable that kerosene, which is made from crude petroleum by fractional distillation, should not be vaporized completely when brought to the temperature at which it was made, but we are familiar with the effect of turpentine and other driers on paint and may conclude that the heavier products are carried along by the lighter. The only safe oil which will vaporize completely is Scotch shale oil, made by the destructive distillation of shale.

This will explain the failure of some of the earlier attempts to vaporize kerosene by passing it over red hot surfaces; in every case the vaporizer became clogged with soot and tarry matter and got out of order. The usual way of using kerosene or other safe oils is to spray them in hot air. Three ways have been used for this purpose: First, a cylinder is provided outside of the engine which can be heated by the exhaust of the engine. The air for the explosive mixture is drawn through this cylinder and is sprayed with kerosene from an atomizer. In order to keep the atomizing cylinder hot enough there must be an explosion for every two revolutions of the engine; that is, the engine must be regulated by throttling the supply of gas and air, and not by omitting an explosion. Second way is to have a bottle-shaped protuberance on the cylinder head which is not cooled by the water-jacket, and consequently gets very hot. The charge of oil is sprayed into this space, where it is partly volatilized by the hot walls and by the hot spent gas. The supply of fresh air is drawn in, compressed, and forced into this bottle-shaped space, where it is charged with oil and can be exploded. The third way is to draw part of the air supply through a heated vaporizer, where it can be charged with oil, and then mingled with fresh air and exploded. In all cases the heating of the air is prejudicial to economy, as has already been pointed out in the discussion of the theory of the gas engine. Again, oil engines are hampered by the fact that spontaneous combustion is likely to occur if the heated charge is compressed to a large degree. Consequently oil engines have a less mean-effective pressure and a less efficiency than gas engines or gasoline engines. This disadvantage is, however, turned to good account by makers of oil engines, who arrange that the compression shall be carried just far enough to cause explosion when desired, and so avoid the use of an igniter after the engine is started. In such case the engine cannot be governed by omitting explosions, for the engine will then be liable to stop.

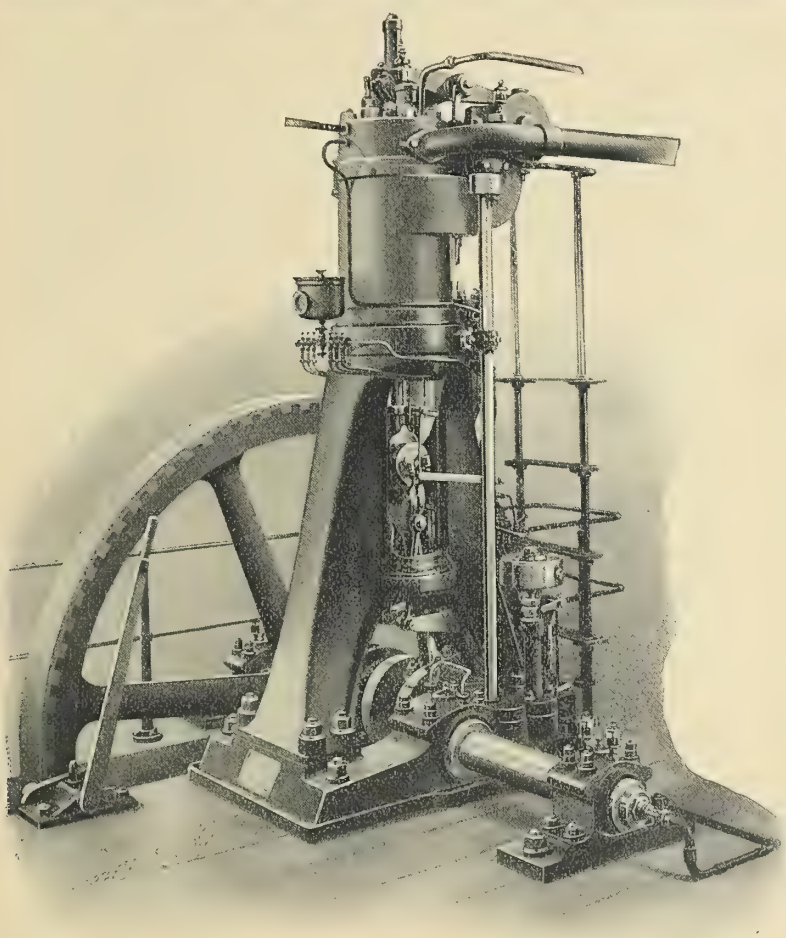


FIG. 17.—DIESEL STATIONARY OIL ENGINE.

All the engines thus far considered work on the Otto cycle and properly should have four strokes to complete the cycle; such as get an explosion for each revolution use a preliminary light compression and depend on the new charge to sweep out the spent gases. There is, however, an old form of engine which has apparently been abandoned which deserves a better fate. I mean the Brayton engine, which produced an indicator diagram much like that for a steam engine. As a gas engine, this engine drew in a supply of air and gas in a compression cylinder and compressed it into a reservoir at about sixty pounds above the atmosphere. The air and gas from the reservoir was allowed to flow into the working cylinder for about half the stroke of the piston, passing through a lamp on the way, where it burned and expanded in volume at constant pressure. As an oil engine air only was compressed, and passing through a combustion chamber burned with oil that was supplied by a small pump. This engine could use crude petroleum, or after it was started

could burn refined kerosine. It appears to have failed because the combustion was incomplete, which is not surprising considering the crude way in which the oil was supplied. The cycle is an old one, used by Ericsson for a hot-air engine, and appears to be worthy of further effort. If a clear, smokeless flame can be secured there seems no reason why the engine might not be a success as an oil engine; but the English makers of oil engines have succeeded in making lamps for heating ignition tubes which have a clear blue flame, and there appears to be no reason why such a flame cannot be obtained at higher pressure. The theoretical efficiency of such an engine compares favorably with that for an Otto engine, and if preheating of the air, as in present oil engines, can be avoided, there is no reason why a good economy cannot be obtained. Such an engine with three cylinders ought to reverse promptly, and could be controlled to a nicety by regulating the oil supply, as there is no necessity to form an explosive mixture.

Before closing this article reference should be made to the Diesel motor, which is now being introduced for stationary work. This engine, which is represented by Fig. 17, differs from the Otto engine mainly in that the clearance is so small and the compression so high that the air which is compressed in the cylinder is heated to about 1,000 deg. F., so that oil sprayed into it burns at once. So far this engine has used crude petroleum because it is cheap, but it can use any oil that can be sprayed in. It is claimed that an engine which indicated 26.6 horse power and delivered 19.2 horse power to the brake, consumed about half a pound of petroleum per horse power per hour.

The engine represented by Fig. 17 is solidly built to resist the high pressure (about 500 pounds per square inch), and is supplied with a heavy fly-wheel. The builders, however, make a three-cylinder engine which has a comparatively light fly-wheel. Marine engines with a number of cylinders (six or more) ought to run smoothly and reverse promptly.

Proposals will be immediately asked by the Bureau of Yards and Docks for the construction of the combined floating and graving steel dry dock, with shore connections and appurtenances, which is to be located at the naval reservation at Algiers, La. The date for closing will be October 31, 1898. Intending bidders can obtain particulars from Mordecai T. Endicott, Chief of the Bureau at Washington. The dock will measure 525 ft. long, 28 ft. draught over keel blocks, and 100 ft. wide in the clear. The dock will be proportioned for a battleship weighing 15,000 tons, 450 ft. long, and having two-thirds of her weight concentrated in the middle half of her length. The fluctuations of water level in the Mississippi are considerable, varying within a range of nearly 20 ft. The limit of cost of the entire works is $850,000.

DISCUSSION OF THE MERITS OF TORPEDO CRAFT AND SOME OF THE FEATURES OF DESIGN AND CONSTRUCTION.—I.

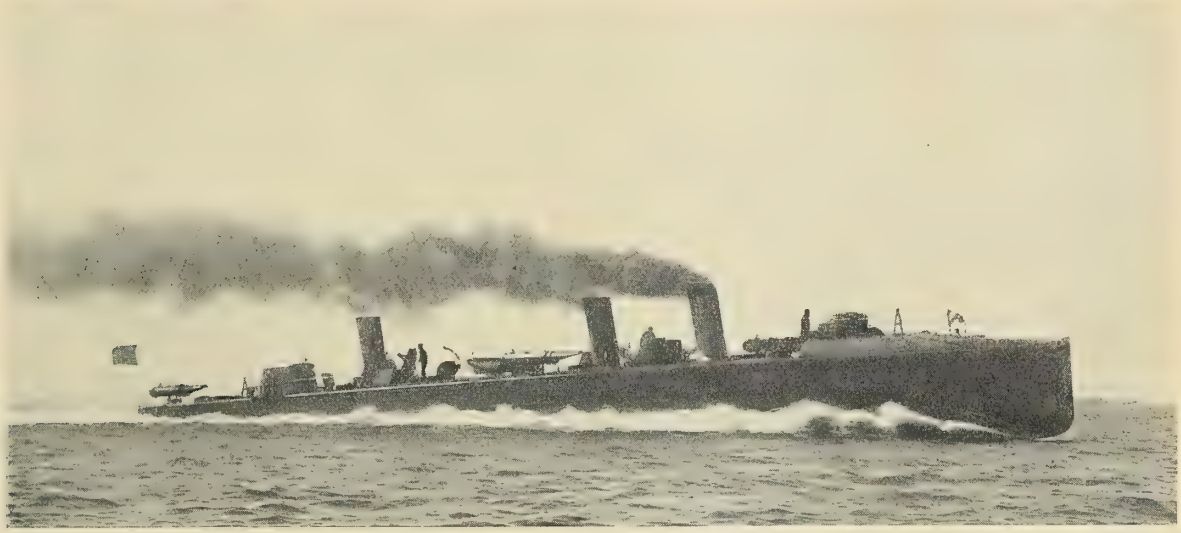
BY WILLIAM A. FAIRBURN.

Although the torpedo-boat is generally looked upon as rather an unknown quantity, yet there is nothing more promising of instructive and interesting development in modern naval warfare than this type of vessel. The Spanish-American war has unfortunately taught us nothing whatever about the efficiency of these high powered boats, and they must still be considered to a certain extent as an experiment. In this war the torpedo-boat has been conspicuous by its absence, and the two Spanish destroyers, "Furor" and "Pluton," at Santiago, could hardly have been expected to do the work they were designed to do, viz.: destroy torpedo-boats or act as torpedo-boats, when they were bottled up in Santiago harbor with a large fleet of powerful warships outside equipped with search lights, making a successful night attack almost as impossible as it would be in broad daylight.

USES OF TORPEDO CRAFT.

The torpedo-boat, like other types of vessels, such as the coast defense monitor, the gunboat for police duty, the scout type of cruiser, etc., is designed to fill a certain place in naval warfare, and if she fails to show up well when ordered to bombard land fortifications or attack heavier boats with her small rapid-fire guns, it does not mean that the type is a failure. The success of a torpedo boat, even in the work for which she has been designed, depends not only on the design and construction of the vessel, but these qualities must be multiplied by a "co-efficient of enthusiasm of the crew," for it is a fact that much of the boat's success or failure will be due to her complement. It is not the purpose of this article to discuss the question historically, but it may be well to state that since their first appearance in crude form thirty-five years ago, these boats have gone through a rapid and surprising transformation. They have developed from the open rowboat, with its spar torpedo, to the swift, high-powered vessel of the present day, carrying large automobile torpedoes. The torpedo-boat is often looked upon as a cowardly craft seeking the destruction of the enemy by insidious means, but "all is fair in war," and the torpedo-boat is designed to take advantage of the enemy's weakness along certain lines of defense. It requires pluck and genuine heroism in many cases for the torpedoist to accompany his missile to within a short distance of the enemy, and his chances of success are not by any means as great to-day as they were twenty years ago. With the present development of the automobile torpedo as a weapon of war 500 yards is the admitted effective range. Darkness, a mist or a fog, will greatly help the attacking torpedo-boat to get within this ef-

fective torpedo range, but as a means of defense the ship attacked will probably have, if one of a squadron at anchor, torpedo-boat destroyers, torpedo and picket boats cruising around and fixed beams of light illuminating zones across which the attacking boats must pass. The search light has been much improved of recent years, and naval men have much more faith in the powerful electric search light and picket boats than they have in booms and torpedo nets. If a squadron is cruising at night, all lights will probably be screened and the fighting ships will assume compact formation, the scouts and destroyers cruising around the fleet to prevent the enemy's torpedo-boats coming within torpedo range of the larger vessels. And yet from actual experiments made in the various navies of the world, it has been proved that the torpedo-boat can very often break through all these lines of defense, and with favorable weather conditions she has been known to often steam to within speaking distance of the ship she was supposed to attack, without being discovered.



Photographed and copyrighted by Frank A. Child, Newport, R. I.

AMERICAN TYPE TORPEDO-BOAT—U. S. S. PORTER BUILT BY HERRESHOFF'S.

CHARACTERISTICS OF DESIGN.

The torpedo-boat should be designed with the following characteristics in view: (1) The boat should be as small as possible, so that she will present a very small target for the enemy, and so that she will be as invisible as it is practicable to make her. (2) High speed is the greatest essential, and all other qualities should be considered but secondary to high speed and the ability to carry the torpedo armament. (3) All noise such as the thud of the engines and the clatter of the blowers should be carefully avoided. Flames shooting from the stacks will make discovery in a night attack certain, and even a large amount of energy expended in wave making may make water disturbances of so violent a nature that when combined with the noise of the machinery it would make discovery most probable. (4) In the design of a first-class torpedo-boat due consideration should be given not only to trial speed in smooth water but speed at sea. Her proportions should not be extreme, and the greater the speed in a seaway the more efficient the vessel will be. (5) Speed can only be obtained by sacrificing other qualities, therefore the weight of hull must be reduced to a minimum. High grade steel should be used and all material judiciously located. The vessel should not be designed with all the fittings of a cruiser and the accommodation of a yacht, but her furnishings should be simple and light and the equipment as light as possible. The complement of a torpedo-boat should be young, vigorous men, capable of roughing it. (6) Economy of coal is an important item, as the amount of fuel necessary to give a required radius of action if large will greatly decrease the vessel's speed. (7) The armament should consist of one or more torpedo guns, according to the size of the boat, located to give the best all round efficiency, and a small battery of 1 to 3 pounder rapid-fire guns should be fitted to repel boarders and engage vessels of her own type. (8) These boats should have good maneuvering qualities, and the smaller type of coast defence torpedo-boats should draw as little water as is practicable, as they must depend to some extent for their safety upon their ability to elude chasing torpedo-boats and destroyers by running into shallow water.

CLASSIFICATION OF TORPEDO CRAFT.

Torpedo-boats can be divided into "three classes," viz.: The Sea-Going Torpedo-Boat, or first-class boat; the Coast Defence, or second-class torpedo-boat, and the Vedette, or third-class boat, which is carried on the deck of a first-

class fighting ship. The first-class or Sea-Going boat should have a length of not less than 140 ft. and a minimum displacement of 120 tons. The second class or Coast Defence boat will probably vary from 80 ft. in length and 30 tons displacement as a minimum to the size of the first-class boat. The third class must be light and small enough to be hoisted on board a battleship, usually from 10 to 18 tons displacement. Although there is a minimum to the question of speed, there is no maximum, and it is usually a case of get all the power and speed you can on any boat of stated size, carrving the stipulated armament and trial load. The speed obtained will show the skill of the builders, for the highest speed can only be obtained with an excellent design and first-class workmanship. A 120-ton boat of the first class should steam at least 25 knots. A 30-ton second-class boat should have a speed of at least 20 knots, and 17 or 18 knots is generally considered good speed for a Vedette or third-class boat. There is, however, another type of torpedo craft which has of late been very popular with the naval authorities of the world, viz.: the torpedo-boat destroyer. The British a number of years ago attempted to reply to the large number of French torpedo-boats by building torpedo catchers or torpedo gunboats. These vessels, with a speed of 18 to 21 knots and a displacement of from 550 to 810 tons, although useful additions to a fleet, did not prove successful as torpedo catchers, the reason being that many of the torpedo-boats afloat at that time had a speed of 26 and 27 knots. Profiting by experience, the British Admiralty in 1893 decided to build a new type of torpedo catcher, which proved to be merely an enlarged torpedo-boat of high speed and great sea-keeping power, with a powerful rapid-firing armament and torpedo guns. The first torpedo-boat destroyers proved very successful, and within the past few years the British have built about 100 of these useful vessels, the speed rising from 26 and 27 knots to 30 knots, and even 32 and 33 knots is spoken of now by two British firms. The displacement of these boats varies from 220 and 240 tons for the 27-knot boats to 275 and 300 for the 30-knot boats. The "Destroyer," as its name signifies, is designed to destroy all types of existing torpedo-boats, and it is desirable that the following qualities should be carefully considered in the design of this type of vessel: (1) High speed at sea is absolutely essential, and therefore the vessel must be much larger than the torpedo-boat, and their proportions should be such as to give great sea-keeping ability. It is essential that the speed should be greater than that of all existing torpedo-boats; but it is well to here note that whereas a moderate sea will reduce the speed of a 140-ton torpedo-boat from 26 to 22 knots, the same conditions will probably reduce the speed of a 300-ton destroyer only about 2 knots. (2) A destroyer should have a powerful battery of rapid-firing guns, capable of destroying any type of torpedo-boat. A battery of 6-pdr. rapid-firing guns is sufficient for this purpose, and the modern practice is to fit such a battery; also a 12 or 14-pdr. R. F. G., which is located on the forward conning tower; some of the larger destroyers carry two of these larger guns. (3) A large radius of action is especially desirable so as to enable these vessels to operate at a good distance from the base of supplies. Economy of fuel is, as in the case of torpedo-boats, a very important item. (4) It is desirable to design destroyers so that they can operate as torpedo-boats whenever the opportunity presents itself; therefore the boats should be as small as possible consistent with sea-keeping power, and almost all the requirements for the successful torpedo-boat apply also to the destroyer.

U. S. BOATS UNDER CONSTRUCTION.

There are now built or building seventeen torpedo-boats and four destroyers for the United States Navy, and in a few days contracts will be awarded for twelve more torpedo-boats and sixteen destroyers. Of the seventeen torpedo-boats now built or building, nine are of the first class, with a displacement varying from 120 to 184 tons, and with a speed of from 24 to 30 1-2 knots. The remaining eight torpedo-boats are of the second class, their displacement varying from 47 to 110 tons and their speed from 20 to 22 1-2 knots. The four destroyers now building are from 235 to 340 tons displacement, and all are designed for 30-knot speed. The new torpedo-boats about to be contracted for are of 150 to 170 tons displacement and probably 26 to 29 knots speed, whilst the proposed destroyers are of 400 to 435 tons displacement and 28 to 30 knots designed speed.

TYPE OF BOAT NEEDED BY U. S.

"What type of torpedo craft do we most need?" is a question that is receiving considerable attention to-day. The writer will answer this question by asking, in the first place, "Why build destroyers?" No foreign nation powerful enough to wage war against us is situated so that it could despatch a torpedo-boat flotilla to our shores. The first-class torpedo-boat is too frail and too small to attempt a great ocean journey, and she requires so much continual attention that it would be unwise to burden a fleet of ocean-going fighting ships with these vessels. The British have good reason to dread the torpedo-boat, and build destroyers to destroy them, for each of the other powerful European nations can send torpedo flotillas against her that will never be far from their base of supplies and repair depots. But with the United States the conditions are very different, and the only torpedo vessels that will ever harass our shores are the larger destroyers. These boats, being larger and more seaworthy than the torpedo-boat, have also a very much greater endurance and they are ca-

pable of keeping their position in a fleet of sea-going fighting ships on the high seas. Then, "Why do we need destroyers when there are no torpedo-boats around our shores to destroy?" Unless the foreign policy of our Government has changed, unless our success in the Spanish-American war makes our future policy aggressive, instead of "Defence and not Defiance," as our motto has always been up to this time, we do not need destroyers. We certainly do need torpedo-boats, and we need large numbers of them both of the first and second class, for our coast line on both the Atlantic and Pacific oceans is very extensive, and the torpedo-boat seems to be an admirable means of defence. It has been stated that we need to build destroyers as a reply to the destroyers that a foe may send against us. None of our destroyers now building is as powerful as the best European vessels of this class. Our policy should be to design and build vessels superior to any that an enemy might send against us, and we should reply to the European destroyer by building a "Destroyer of Destroyers." Such a vessel would require a higher sea speed than any destroyer at present afloat, an armament powerful enough to sink any torpedo vessel, armored protection sufficient to resist the fire of a destroyer, and, lastly, great endurance. A large destroyer of 450 tons trial displacement could be designed to fulfil all of these conditions, the protection consisting of 2-inch nickel steel and the radius of action about 6,000 miles. The armament could consist of two 4-inch and six 6-pdr. R. F. G. and one torpedo gun, which is greatly superior to that of any destroyer built or building. The 400 to 435-ton destroyers for which contracts will soon be awarded are not as powerful as the latest European destroyers, but such a vessel as here proposed, a "Destroyer of Destroyers," could be built for very little more money and would be capable of destroying any vessel of the torpedo-boat or destroyer types afloat. The writer therefore strongly advocates the construction of torpedo-boats and armored-destroyers, and unless we are going to meddle with European politics and commerce an aggressive foreign policy and a tour of conquest, we do not require the ordinary destroyer. Such vessels could but act as torpedo-boats, and their cost would be twice as much, for the cost of torpedo vessels varies almost directly as their displacement.

CONCERNING CONVERTED YACHTS.

It is amusing to-day to hear misinformed persons denounce the torpedo-boat and praise the type of auxiliary war vessel—the converted yacht—which has been popularly termed in our daily newspapers the "torpedo-boat destroyer." The splendid fighting of the "Gloucester" (formerly steam yacht Corsair) at Santiago is undoubtedly responsible for much of this talk. Why not condemn likewise the armored cruisers? for truly all the Spanish vessels failed alike to show up well when brought face to face with a powerful enemy, consisting of the finest fighting machines afloat and a complement of a decidedly superior quality. The writer has seen much of the European destroyers and the personnel of these vessels, and when manned by men of the Anglo-Saxon type they will not only keep the destroyer of the converted yacht type guessing—owing to their speed being just twice as great—but their armament is much more powerful than that of the converted yacht. Steam yachts will undoubtedly always do good work in the auxiliary navy as picket- or despatch-boats, but they must never be considered as in the same class with torpedo-boat destroyers.

DIFFICULTIES OF TORPEDO-BOAT DESIGN.

A practical ship-builder, with little or no knowledge of the science of naval architecture, may successfully build coasting schooners or passenger steamboats, but when it comes to torpedo-boat design, practical experience and guesswork amount to nothing, and theory, science and art must take their place. The practical construction of the torpedo-boat is as much different from that of the merchant steamer as the mechanism of a watch is from that of a tower clock. No shipbuilding firm will ever make a success of torpedo-boat construction which does not appreciate the delicacy of the work. Big ship methods must be discarded, the "guess of about so much" omitted, and all parts of the vessel and her machinery carefully proportioned to withstand a certain stress with a certain factor of safety. A special department for the construction of torpedo-boats is a most desirable arrangement when large shipbuilding firms contract for this type of vessels, and a first-class designer and theoretical man, together with a first-class practical man experienced in this class of work, are essential if the establishment is to make a success of the construction of torpedo craft. Shipbuilding firms that appreciate the greatness of the undertaking, the delicacy of the work, the difficulty and necessity of obtaining a good design, and the many obstacles that will have to be overcome before they can obtain the required speed, when they make their estimate of cost will probably make a success of this class of work. First-class technical men can be obtained to take charge of the work if the inducements made are great enough. The difficulties of torpedo-boat design are alike in both hull and machinery. The hull must be designed as light and as rigid as possible consistent with strength, and of such shape as to be easily propelled through the water the required speed. The machinery must be capable of developing maximum power with the least possible weight, and it must also be durable, compact, accessible and economical.

HINTS ON DESIGNING THE MODEL.

Let us first consider the design of the model. The lines of the vessel must be adapted to the

designed high rate of speed, and they must be capable of carrying the machinery and forming a suitable platform for the torpedo guns. It is quite common in torpedo-boats designs to see the boiler located in the design and the vessel's lines made to conform to this "tight section." Great natural strength should be considered when getting out a set of lines, and the nearer the vessel approaches to a tube in shape the more natural strength she will possess. The weight of hull and the strength of the vessel should be considered when the lines are being made, for it is possible to get a stronger hull of less propulsive efficiency which might show up better in the aggregate than an easier lined vessel which requires heavier scantlings to obtain the same strength. The transverse sections should be a fair curve throughout, with no straight lines or quick turns. It is usually advantageous to locate the greater beam above the load water line, with a rapid tumble home between this point and the deck. The former point is to increase the vessel's stability, and is based on the experience of the French government with torpedo-boats, whilst the latter feature is to save weight and increase natural strength. When a torpedo-boat reaches a speed given approximately by the formula $9\sqrt[6]{\text{Disp.}}$ the boat will commence to rise out of water, and the displacement will gradually be diminished as the speed increases. If the stern transverse sections are V-shaped the boat will squat aft as the bow rises. The only means of avoiding this disagreeable squat, which is accompanied by a considerable loss of stability, is to use a broad, flat stern. Even with the best broad stern obtainable the change of trim will be considerable when the boat gets up to her maximum speed, but such a stern will not sink beyond the knuckle; on the contrary, the bow will steadily rise, and the total displacement will diminish after reaching the rising speed, as already stated. The following figures will prove interesting, as they give the speed at which torpedo-boats and destroyers will commence to rise out of water:

Displacement.	Rising Speed.
25	15.4 Knots
50	17.3 "
100	19.4 "
150	20.7 "
200	21.8 "
300	23.3 "
400	24.4 "
500	25.4 "

The great change of trim noticeable on torpedo-boats when running at high speed is not however caused entirely by the bow rising and thus decreasing the displacement; the boat runs along on the back of a transverse wave having a speed equal to her own, so that her change of trim in respect to the horizon is considerable more than that shown by the water against the side of the boat. The phenomenon of change of trim brings into prominence an essential feature of torpedo-boat design, viz.: the matter of keeping the forefoot very deep and almost square in order to avoid shortening the effective water line length when running at high speed. It will be readily seen that any part of the boat forward of the speed water line is so much useless appendage, and when economy of weight is such an item as in torpedo-boats, overhanging bows and such like appendages should be avoided. The spoon and semi-spoon bow—in longitudinal elevation—is being adapted somewhat now on the latest American designs, but the writer fails to see why the weight of such a stem should be added and why the appearance of a boat should be spoiled by such a forward ending. A torpedo-boat with a plumb stem and bow sections flaring above the load water line is an unusually dry boat forward in a sea way, and French builders do not even consider a turtle back forward desirable. Many of the pet theories of some of our torpedo-boat designers would, I think, be dashed to the ground if they had actual sea experience on a correctly modeled torpedo-boat. The standard ratio of length to beam on the water line of torpedo-boats is 10 to 1, but it varies from about 9 to 11 for first-class sea-going boats. The beam when stated is often given as the maximum molded beam, and the water line beam on some boats is as much as 9 in. less than this dimension. The smaller the boat the wider she must be so as to obtain the necessary stability. The broad flat stern increases the initial stability considerably, for besides raising the center of buoyancy it greatly increases the area and moment of inertia of the water plane, and therefore raises the metacenter, whereas the center of gravity of the hull is raised but little. The deeper the boat, the more natural strength she will have, the more freeboard she will possess, and the more room there will be in her interior for the machinery and quarters.

Description of Auxiliary Naval Vessels.

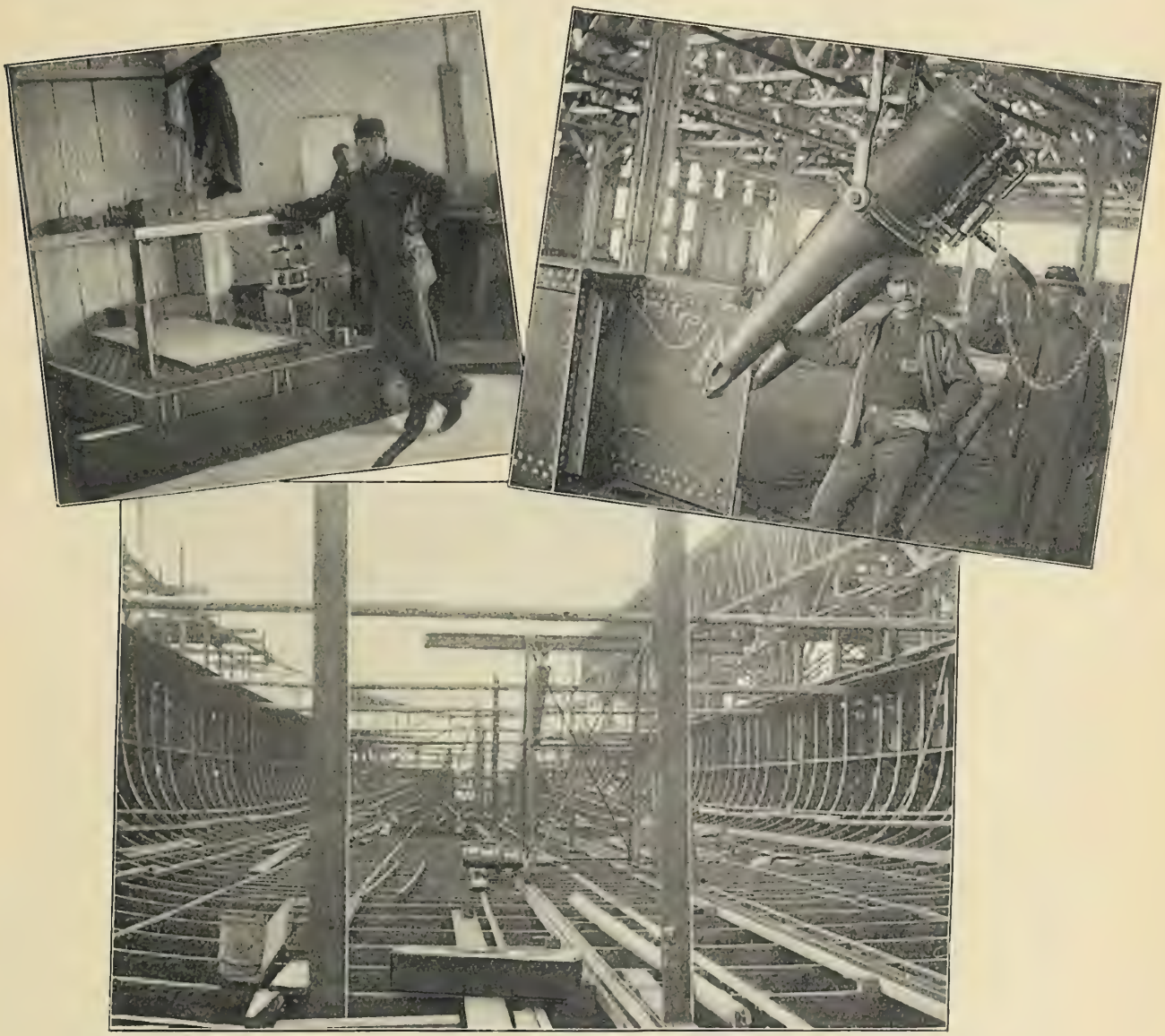
Since the publication of our fourth list (in August) of vessels secured by the Navy Department for use as auxiliary naval vessels, the war has been brought to a close by peace negotiations. Already preparations are being made to put out of commission several naval vessels, and to sell or otherwise dispose of auxiliary vessels. It is probable that some vessels of the collier type will be retained by the Department. It will be some time, however, before any final disposition is made of all the vessels added to the Navy since the beginning of the Spanish-American war. The lists we have published are brought up to date by the addition of one vessel, of which the following are the particulars: Old name and date of build, Luciline, 1893; old class, freight steamer; length, 332 ft.; beam, 42 ft. 2 in.; depth, 26 ft. 5 in.; tonnage, 3,319 gross; where built, Stockton, England; former owner, A. Suart; new class, water boat and tank steamer; new name, Arethusa.

EXPERIENCES WITH COMPRESSED AIR IN SHIP-BUILDING AND SHIP-YARD WORK.

BY WILLIAM BURLINGHAM.

Of late years great advances have been made in the use of compressed air as a motive power for small tools, and it is already considered on an equality, and for many operations, superior to steam, electricity or hydraulic power.

Practically all the large railroad and ship-building plants in the country have adopted this form of power in a greater or less degree. It is possible to convey it from point to point with great facility and practically no drop in the pressure, though the pipes may be very long: For example, at the Jeddo Tunnel, in Pennsylvania, air at 60 lbs. pressure was carried 10,860 feet, and the guages at both ends of the pipe showed no difference in pressure. There are many other instances of this kind, where it would be practically impossible to convey steam, and consequently a small boiler with fireman would be necessary at the scene of operations. Other advantages are that it lends itself for use in all kinds of holes and corners. There is very little, if any, danger from frost, if the pipes are properly laid, protected and drained. There is no chance of short circuits or unforeseen shocks; no solenoids or delicate armatures to get out of order and no heavy mass of iron and copper to transport in the shape of an electrical motor, for the purpose, for instance, of drilling a 3-4 in. hole. There are no leaky joints as in hydraulic motors, and no trouble from condensation and lack of positive movement as in steam.



PNEUMATIC DRILL AND PORTABLE RIVETERS, IN SHIPYARD WORK.

Its economy is equal, if not superior, to any of the existing prime movers, if used with judgment and due regard for its capabilities and for the

right tools; that is, for those various small tools that are located at a considerable distance from the source of power, operating in many different places in a short interval of time.

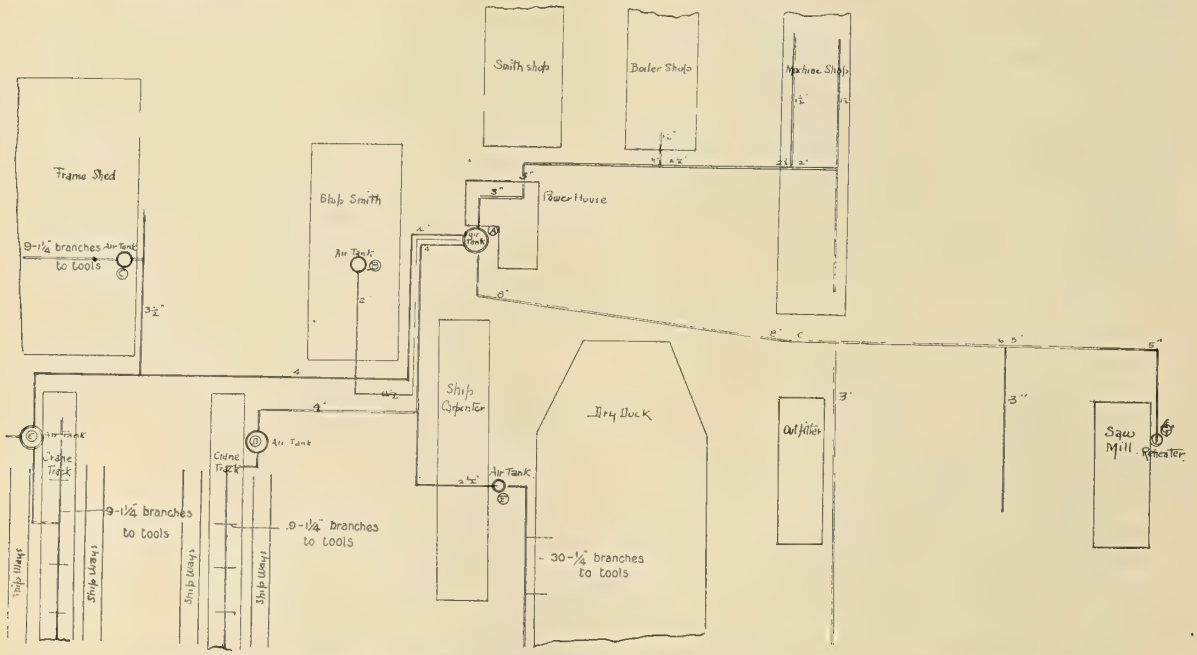
It is the general opinion that air, water and steam are pre-eminently suited for pressure operations or where blows are to be delivered, and electricity for rotary motion. Experience, however, has taught that for hand tools, both rotary and reciprocating, the air engine has most advantages in establishments where light and easily handled tools are a necessity.

The fact that an ordinary mechanic can repair and adjust air motors, while it requires an expert electrician to repair an electric motor, would seem to make it preferable to use the former method, as ordinary mechanics are more numerous in a shipyard than expert electricians.

Compressed air should be used and not abused. Small leaks are very prevalent in the piping, valves and loose couplings, and worn out motors often consume an excessive quantity of air. These are very small matters in themselves, but taken collectively in a large plant, have a very depressing effect upon the coal pile and an elevating one on the expense account. Treat the air plant with the same care that is manifested in the insulation of electric wires or lagging of steam pipes and there will be less grumbling heard concerning the wastefulness of the system. A committee of the Master Mechanics of the principal railroads of this country reported at the last meeting, 1897, that the use of compressed air, with suitable apparatus, gave an average economy of from 25 to 50 per cent. over the ordinary former practice, in their shops, on the following work:

Tapping out stay bolt holes, reaming and drilling holes, chipping and caulking, removing tires, beading flues, air hoists, vertical and horizontal car jacks, tinware presses, shears erected outside shop for shearing off test coupons, tank riveters, shears at scrap pile, shears for light sheet iron work, small Pelton wheels for operating emery wheels, blast for blacksmith forges, applied to mixing paint in large quantities by putting a pipe in bottom of mixing barrel, used in all kinds of motors for boring cylinders and facing valves, cleaning cushions inside and out of cars, blowing out cylinders before inserting packing, rolling flues, swedging flues, testing brakes and numberless other minor purposes.

The following particulars were given of a shop turning out sixty engines per year, viz: One compresser with 15-in. steam, 14-in. air cylinders and 18-in. common stroke, five elevators, one hoist for driving wheel lathe, six hoists for lathes and planers, two Brotherhood engines, three motors, one sand elevator, one fire kindler and one flue cleaner. The cost of this compressor, including foundations and pipe connections, was $1,260.50. Pipe lines, hose, valves, reservoirs, motors, hoists, elevators, cost $1,189.50. A total of $2,450.

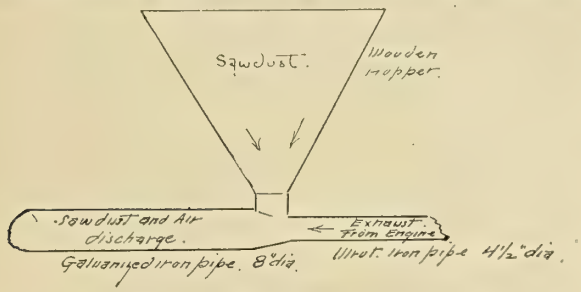


SYSTEM OF COMPRESSED AIR PIPING AT THE NEWPORT NEWS, VA , SHIPYARD.

On a test run of eight hours it required 313 lbs. of coal per hour or 2,508 lbs. for the run. Pressure was raised from zero to 120 lbs. in 5 minutes 40 seconds. The compressor made 858 revolutions and compressed 2,681.6 cu. ft. of free air to 193.9 cu. ft. of air at 120 lbs. It required with this compressor 20.4 lbs. coal to compress 1,000 cu. ft. of free air to 120 lbs., equaling 60 per cent of its theoretical capacity. The packing of this engine had not been overhauled for eighteen

months, thus accounting for some of the deficiency.

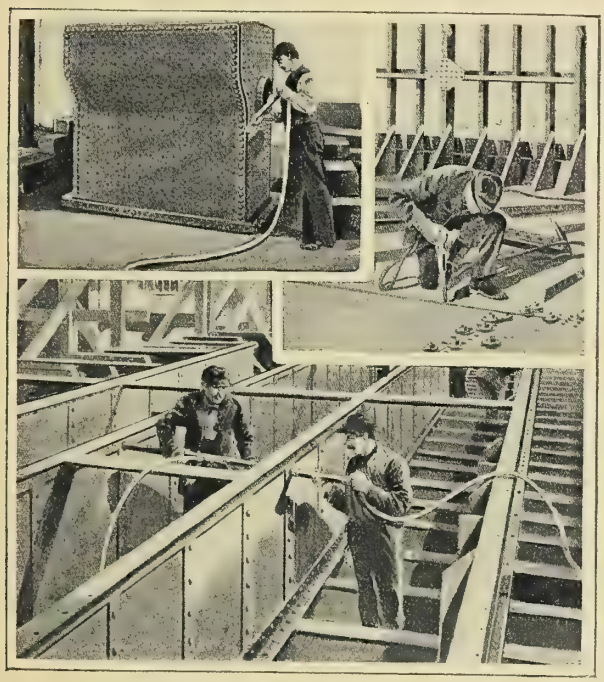
It is during the building of a ship that the advantages of these power tools are best exemplified. A hull is full of odd corners and nearly inaccessible nooks that must be as well riveted and caulked as the most accessible part of the



PNEUMATIC SAWDUST EJECTOR.

vessel; perhaps better, as it is more difficult to overhaul and examine these places.

It is not so long ago that the best yards in the country depended upon the ratchet drill and hand riveting, the work having to be done in such inconvenient places and uncomfortable attitudes upon the part of the workmen as to preclude the possibility of a first-class job. Now from the driving of the first rivet in the keel to the launch of the vessel the continuous clatter of air riveters, caulking tools and the whirring of rotary



CHIPPING, CAULKING AND RIVETING WITH PNEUMATIC TOOLS.

drills are sure indications of rapid progress toward completion.

Probably one of the largest and best equipped air plants for the use of small tools is located at the works of the Newport News Shipbuilding and Dry Dock Co. Comparatively new, this air plant now furnishes the power for the majority of the tools used on the outside work of the various naval and merchant vessels building there, to the exclusion, almost, of steam and electricity.

The original plant consisted of a small Rand compressor and a few tools; then a couple of Pedrick and Ayer compressors and more tools were added. Now, hardly more than three years since the starting of the initial plant, there are in operation three Ingersoll & Sergeant compressors, viz:

One class G, half-duplex-slide-valve compressor, with 20-in. steam and 20-in. air cylinders and 24-in. stroke, run at 94 revolutions per minute, with a capacity of 1,600 cu. ft. of free air. The air discharges through a 5-in. pipe at 100 lbs. pressure.

One class G duplex compressor with 20-in. steam cylinder, 20 1-4-in. high-pressure air cylinder and 32 1-4-in. low-pressure air cylinder and 24-in. common stroke. This engine has a receiver inter-cooler 36-in. dia. by 9 ft. 6 in. long, and discharges at 100 lbs. pressure.

One class G duplex compressor, with 20-in. dia. steam and 20 1-4-in. dia. air cylinders and 24-in. common stroke, with a capacity of 3,200 cu. ft. of free air per minute and 100 lbs. pressure at discharge.

These compressors are all made with the piston inlet air cylinders, are water jacketed and are furnished with a governor automatic pressure regulator. The compressed air is discharged into a storage tank common to all at about 90 lbs. pressure.

These storage tanks are a necessity and should be of such size as to enable the engines, after once filling them, to run at a moderate speed during working hours.

The tanks are usually provided with pop safety valves, ample drainage, and from the first tank a small pipe is led back to the automatic regulator on the engine. From this main tank the air is carried by mains to smaller storage tanks located at different points in the yard, nearest the centres of work.

By constructing the storage tanks with a baffle plate down the center, the air entering at the top impinges upon the plate, delivering the entrained water into the botton of the tank, from whence it is drained at intervals. The air then passes under the baffle plate and out again at the top of the tank. The air pipes should always enter and leave the storage tanks at the top.

The drawing on page 16 is a plan of the yard piping. The main air pipe is about 1,500 ft. long, of cast iron, with leaded joints, 8-in. inside dia. and reduced at intervals to 6 in. and then to 5 in. At the end it enters a reheater similar to a surface condenser about 27 in. dia. and 6 ft. long, with wrought iron tubes 1 1-4 in. dia., and is there heated by the exhaust steam from one of the shop engines. This reheated air is employed to run a

regular type Atlas horizontal steam engine that furnishes power for a large band sawmill. The exhaust air from this engine is employed to force the sawdust from the mill as it accumulates. The device is shown on page 17. The air pipe to the engine is 3 1-2 in. dia. and the exhaust 4 1-2 in. dia. The reheater also supplies air to a small motor for a saw grinding machine.

At any point in this system the pressure guage will register the same as at the main tank, and even under the most unfavorable circumstances there is but little appreciable drop. There are four other mains leading from the storage tank, two 4 in., one 3 in. and one 2 1-2 in., all wrought iron pipe with screwed joints. All pipes used in connection with this plant are buried in trenches below the frost line.

The 2 1-2 in. main has supplied power sufficient for twenty-eight No. 2 Boyer hammers and four drills, but this was the full working limit of the pipe; about two-thirds this number would be a preferable load. The hammer supply nozzle is 1-4 in. and the drills 3-8 in. pipe taps. The yard has used nearly every type of pneumatic machine that is manufactured and even now have many different types in use.

Some of the different operations performed by the tools are shown in the group picture on page 17. In everyday use many of the tools work more satisfactorily than others, in the matters of economy, in the use of air, freedom from breakdown and the not least important absence of vibration. Indeed, some tools which work satisfactorily in the first two named respects, are very severe on the workmen. They are all liable to break in one part or another, but the manufacturers are constantly improving and strengthening the weak parts as they are taught by experience.

The pneumatic riveters are a little larger than the hammers or caulkers, with a head that fits the head of the rivet. The work of driving the rivet is done by a large number of comparatively light blows instead of a single squeeze as in a hydraulic machine. This permits of the use of a very light frame for holding the riveter. The latest type is that patented by the Detroit Dry Dock Company, and is made of 2 1-2 in. W. I. gas pipe, bent to a U shape, with a gap of about 60 in. This frame enables the workman to reach rivets that are absolutely unapproachable otherwise than by hand riveting. Nearly all makes of pneumatic drills are practical; some are more powerful than others for the same weight. Their great difference is in their economy. All are extremely liable to breakage in some minor points, and a small repair shop is a necessity where many pneumatic tools are used. The drills are made in three types, the movable cylinder, the movable piston and the rotary, similar to the rotary pump; these last are great consumers of air and are not to be recommended where economy is a feature. The movable cylinder type, at the present date, seems to be the most economical and is at the repair shop the least often, considering the amount of work done by it.

It is necessary that care be taken to keep these machines clean, well oiled and in good working order. Proper lubrication is an essential requirement, both as to quality of oil and frequency in applying it. The best winter strained lard oil or valvoline sewing machine oil are recommended. Should it become necessary to clean the machine, admit kerosene and turn slowly while the grease is dissolving, and when all is dissolved admit air through the throttle. Thoroughly lubricate again before using.

As these machines are made interchangeable, the parts most liable to break should be duplicated in store. These cost but little and afford a most excellent insurance against stoppage from breakdowns.

For work in the frame sheds, on bulkheads and reverse frames the Caskey or single squeeze pneumatic riveter is used. This is a very good and efficient tool; it is usually slung from a jib crane with a long jib, by a chain twist, and thus commands a large area.

The larger illustration on page 15 shows this riveter at work on the double bottom of a battleship. A track was laid down the center of the inner bottom. This was for the crane carriage. The riveter, as shown, is held by a neumatic hoist. This was found to be a poor arrangement, as the elasticity of the air in the pneumatic hoist prevented a rapid setting of the hammer on the rivet. A Weston chain hoist was afterward used with success.

For general work about the yard a see-saw arrangement was devised, consisting of a beam, supporting the riveter at one end, with a counter balance at the other. The beam rested on an A frame carriage. This allowed a great latitude of movement and was eminently successful. It is shown in the upper right hand cut in the group on page 15.

The amount of work done by these pneumatic machines is greatly dependent upon the workman, and the men must be picked by actual trial to secure the best results.

AMERICAN STEEL FOR BRITISH SHIPYARDS.

Export orders for steel plate for the Clyde and for Belfast, Ireland, are now being filled in this country. The Illinois Steel Company has closed a contract with Harland & Wolff, the great Belfast, Ireland, shipbuilding firm, for a consignment of high grade open hearth material. Through the courtesy of the company we are enabled to here present a view of the plate mill, showing the ingot runway in the foreground and the mill tables and rolls further away. In this fine mill manual labor is dispensed with as much as possible in the actual operations of steel making. Men are only employed for manipulating the

steam, hydraulic and electrical apparatus, which replaces the old-time methods of steel making.

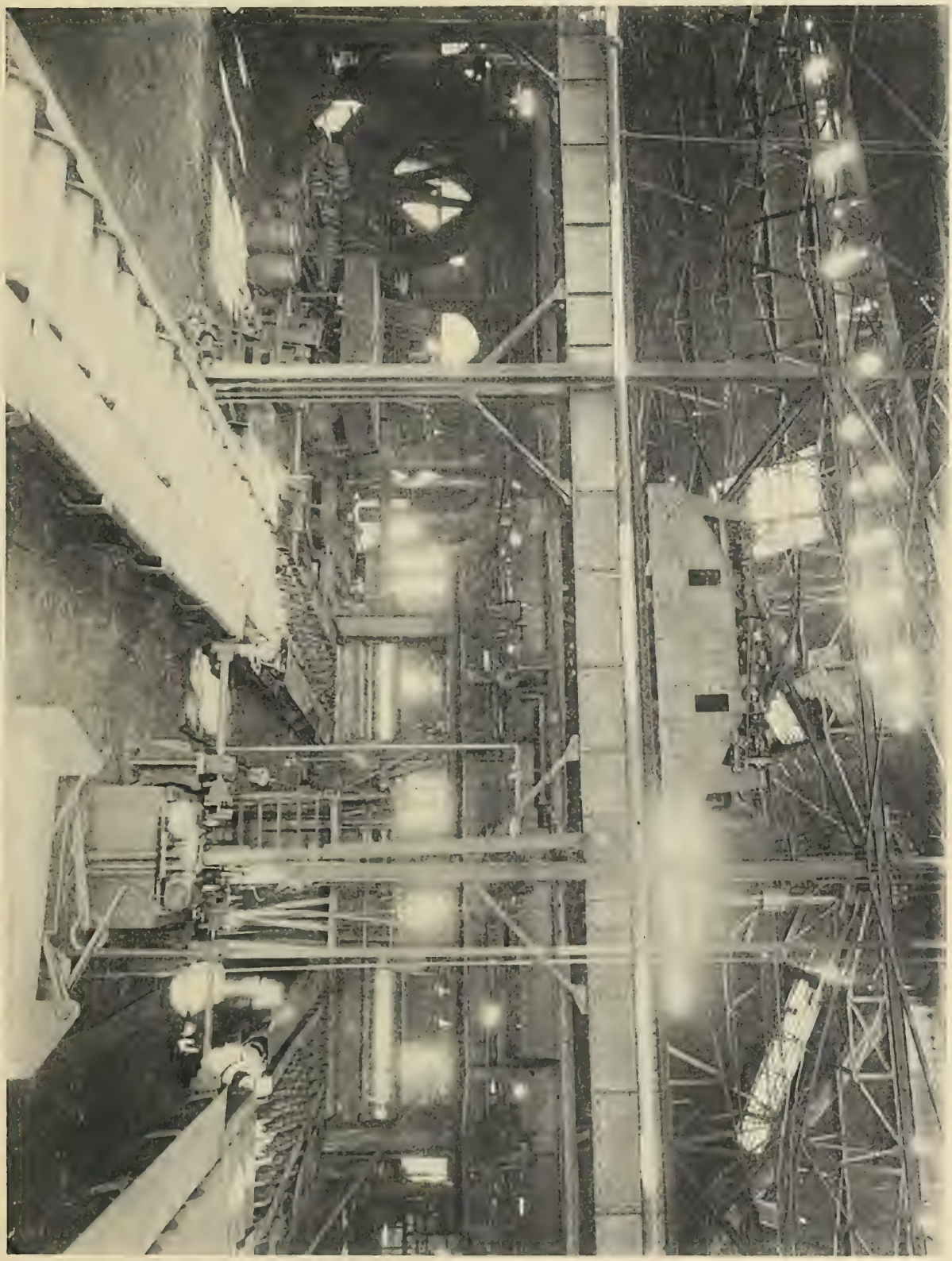


PLATE MILL IN THE OPEN-HEARTH STEEL DEPARTMENT OF THE ILLINOIS STEEL CO. AT SOUTH CHICAGO, ILL.

As showing the high quality of steel now turned out on this side of the Atlantic, we have secured photographs and particulars of test pieces cut from orders recently filled by the Illinois Steel Company at its South Chicago plant. Both the plate and bar steel shown were rolled from open hearth steel for two large Scotch boilers for the Lake steamer W. R. Linn, built by the

Chicago Shipbuilding Company, at South Chicago. The boilers were constructed at the establishment of John Mohr & Sons, at South Chicago.

The cold bend test of the shell plate was made with a test piece 1 15-32 thick, of open hearth steel, made to the U. S. marine specifications, as follows:

Elongation .....25 per cent in lengths of 6 in.
Reduction of area.....Not less than 40 per cent.
Tensile strength.....Not less than 60,000 lbs. per sq. in.
Phosphorous .....Not more than .06 per cent.
Sulphur ..... .04 per cent.

The actual physical and chemical results of the piece of plate were as follows:

Tensile strength per sq. in .....60,530 lbs.
Elongation in 6 in.....27.33 per cent.
Reduction of area .....49.94 per cent.
Chemical Analysis:
Carbon ..... .29 per cent.
Sulphur ..... .03 per cent.
Phosphorous ..... .033 per cent.
Manganese ..... .37 per cent.

The other test was also a cold bend test of open hearth steel, 2 5-8 in. dia., for stay bolts for the boilers.

This steel was made to the following specifications:

Tensile strength.....50,000 to 58,000 lbs. per sq. in.
Elongation .....35 per cent in 2 in.
Reduction of area.....50 per cent in test piece 5-8 in. dia. and 2 in. between fillets.

Cold bend test of full size bar to stand bending round a curve, the inner radius of which is equal to one and one-half times the diameter of the finished bar, in accordance with the rules and regulations of the Board of Supervisors of Steam Vessels of the U. S. Government.

Sectional area of billet from which the rod is to be rolled shall not be less than four times that of the finished bar at the rolls.

Test piece to be machined out of the finished bar. The center of the test piece to be midway between the center and circumference of the finished bar.

Phosphorus and sulphur, not over .03 per cent.

Manganese not less than .30 nor over .50 per cent.

The test of the steel produced for this order gave these results.

Physical Results of Machined Test Piece:
Tensile strength .....54,270 lbs. per sq. in.
Reduction of area .....51.49 per cent.
Elongation .....35.50 per cent in 2 in.
Chemical Analysis:
Carbon ..... .20 per cent.
Sulphur ..... .027 per cent.
Phosphorus ..... .011 per cent.
Manganese ..... .43 per cent.

The radius of the bend shown in the engraving is 1-2 in., or a much closer bend than that required by the government test.

The boilers for which this steel was rolled were designed for a pressure of 200 lbs. per sq. in. The dimensions were: Dia., 14 ft. 8 in.; length, 11 ft. 6 in., each having three Morison furnaces 44 in. dia.

The open-hearth steel department of the Illinois Steel Co., at South Chicago, was put in operation in February, 1895. The building containing the furnaces and casting pits is of brick and steel construction, 100 ft. wide and 651 ft. long.

The furnaces, ten in number, are placed along the length of the building, giving half of the width of the building for casting and for handling ingots, molds and slag. Back of the furnaces is a charging floor twelve feet above the yard level. The charging floor and furnaces are spanned by a 20-ton electric traveling crane. Over the front of the furnaces and the rest of the building, running parallel to its length, are one 40-ton, two 30-ton and two 75-ton electric traveling cranes. There are four open-hearth steel furnaces of 25 to 28 tons capacity for each heat. These are of the Wellman stationary type of the Siemens regenerative furnace, and there are also two 25-ton and four 60-ton furnaces of the Wellman rolling type. The annual capacity of these ten furnaces is 175,000 tons of ingots and castings.

Stock for charging the furnaces is loaded at the mills of the stock piles in boxes on freight cars, which are carried on an inclined track to the charging floor and placed directly in front of the furnace doors. The boxes are picked up, pushed into the furnace, emptied and replaced on the car by Wellman electric charging machines, of which there are three in use. All doors and valves of the furnaces and regenerators are operated by pneumatic cylinders, the cocks of which are worked by a boy on the charging floor. The melted steel is tapped into ladles of 30 to 60 tons capacity, which, being suspended from a traveling crane during casting, are at once taken to a pit full of empty molds. A steel-lined casting pit 30 ft. deep permits the casting of ingots of great size and weight, up to 150 tons each. The making of small and intricate castings is quite as carefully attended to as of those of greater size.

The plate mill was built simultaneously with the open-hearth building. There are five large reheating-furnaces served by two Wellman electric charging cars. Two plate trains, one 90-in. and one 132-in. in length of rolls, are driven by a 54 in. by 66 in. Porter-Allen engine of 3,000 horse power. They are three-high, having the middle roll operated vertically by hydraulic pressure. Finished plates are made from 3-16 in. to 1 1-2 in. thick and up to 126 in. wide and 60 ft. long. The capacity of the mill is 84,000 tons of finished plates a year. Much of the machinery in these two departments is electrically driven. A high speed of movement and ease of handling plates of any size rolled are obtained by the use of strong electro-magnets, suspended from traveling cranes, which will pick up, transport and lay down plates simply by turning a switch.

Shears of great strength cut plates to any size or shape ordered. One of these shears cuts circular plates with great accuracy. The largest shearing machine has blades 11 ft. long, capable of cutting a plate of that width and 2 in. thick.

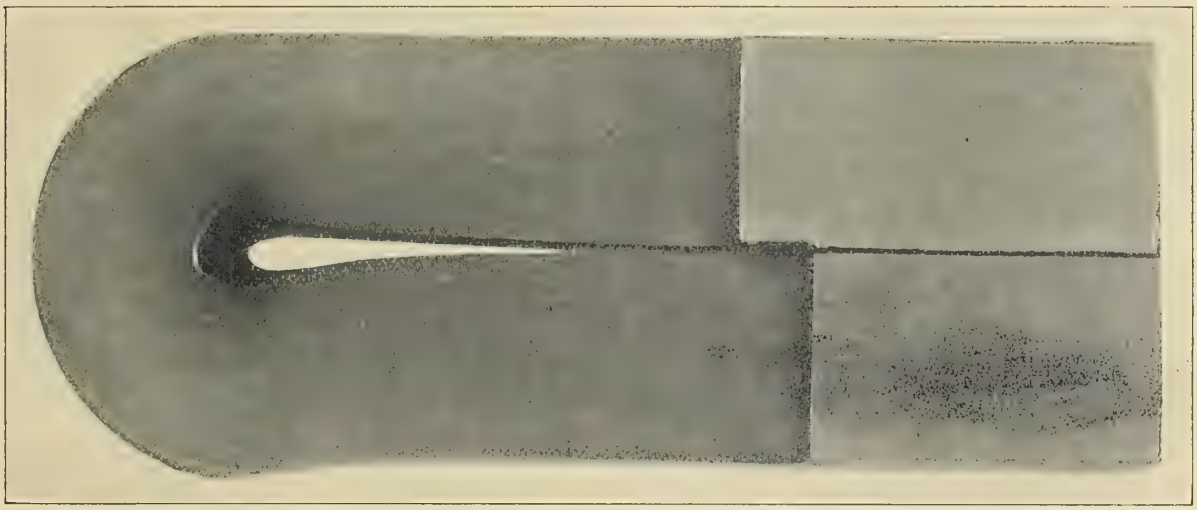
TESTS OF OIL AND COAL AS FUEL ON THE HYDRAULIC LIFEBOAT QUEEN.*

BY JOHN PLATT, M.E.

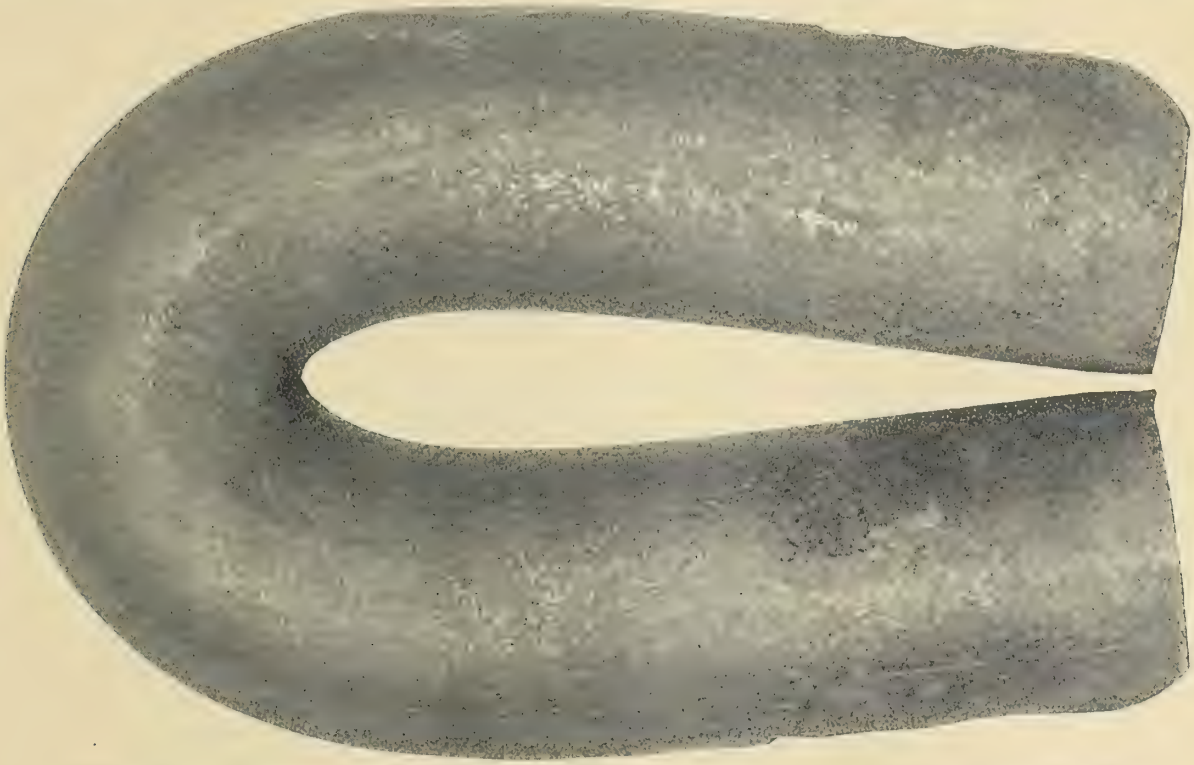
A series of experiments having been made burning both coal and oil in a Thornycroft boiler in the new hydraulic lifeboat Queen,[1] built by John I. Thornycroft & Co., for the Royal National Life Boat Institution, it was thought that a general description of the boat and the results of the experiment would be of interest to the members of the American Society of Naval Engineers.

The general question of hydraulic propulsion has been dealt with by S. W. Barnaby, in a paper before the Institution of Civil Engineers.[2] He also describes a previous hydraulic lifeboat the "President Van Heel."[3]

The vessel was designed by G. L. Watson, the naval architect to the Royal National Lifeboat



COLD BEND TEST, 1 15-32 IN. OPEN-HEARTH STEEL PLATE FOR MARINE BOILER.—SEE PAGE 18.



COLD BEND TEST 2 5-8 IN. DIA. OPEN-HEARTH STEEL FOR STAY BOLTS.—SEE PAGE 18.

* From a paper read before the American Society of Naval Engineers, Washington, D. C.

1 For illustrated description of this boat see January issue, page 17.

2 Proceedings of Institute of Civil Engineers, London. Vol. 77, p. 1.

3 Proceedings of Institute of Civil Engineers, London. Vol. 130, part IV.

Institution, who furnished drawings and a specification, the builders, John I. Thornycroft, being responsible for the design of the machinery, and for the attainment of a speed of 8 1-2 knots.

The particulars of the vessel which is named the "Queen" are:

Length over all	55 ft.
Length on W. L.	53 ft.
Breadth moulded	13 ft. 6 in.
" over sponsons	15 ft.
" extreme over belting	16 ft.
Depth moulded	5 ft. 6 in.
Draught extreme	3 ft. 6 in.
Displacement	30.08 tons.

The hull is closely subdivided, and the bulkheads are intact, the only watertight doors being in the coal bunker bulkheads. Access is obtained to the small compartments for the purpose of examination and painting by manholes jointed with red lead in the bulkheads above the water line. Longitudinal wing bulkheads extend for a length of 25 ft. 6 in. on each side, enclosing the machinery space. They are 2 ft. 6 in. from the side at the height of the water line amidships. They considerably reduce the volume of the machinery compartments, which are unavoidably long, and afford security in case of injury to the boat's sides. The wing compartments are subdivided by athwartship bulkheads, and on each side of the boiler room one of the compartments thus joined is used as a coal bunker. Two strong side protective keels of American rock elm are fitted between angle bars, the bolts going through the flanges of the bars, and not through the bottom plating. These are placed under the longitudinal side bulkheads, and are an effective protection to the pump inlet and to the bottom. In the stern is the open cock pit capable of holding about forty-five people. The deck of the cock pit is above the water and watertight. It is provided with the usual freeing valves to allow of the rapid exit of the water in case of a sea being shipped. The rudder projects below the bottom of the boat in the usual lifeboat fashion; the rudder head is hexagonal in section for a length of about two feet, and can slide up and down in a quadrant into which is geared a worm spindle which carries the steering wheel at its inboard end—the rudder can rise if it strikes the bottom, or can be triced up with tackle provided for the purpose without disconnecting the steering gear. At the forward end of the cock pit, upon the engine casing, is a steam capstan, and a steel wire rope hawser is coiled on a reel close to it. A wire rope nipper is placed upon the forecastle and an arrangement is provided for cutting the hawser in case of need. There are two sails, a dipping lug and a fore stay sail. The mast can be hinged down upon the top of the boiler casing.

A double compound surface condensing inclined engine is used, having cylinders 8 1-2 in. and 14 1-2 in. in diameter, by 12 in. stroke. The air and bilge pumps and the two feed pumps are driven from the main engine. An independent engine and circulating pump supplies water to the condenser. The usual auxiliary feed pump is placed in the boiler room. The main turbine and casing are of bronze, zinc protectors being provided to prevent galvanic action between pump and the shell of the boat, should the zinc coating of the latter be worn off. The inlet pipe is of steel and the discharge pipes are of copper. The diameter of the turbine is 2 ft. 6 in., and at a speed of 9 knots the discharge is about 2,240 lbs. of water per second. The nozzles are 9 in. in diameter. These nozzles are carried well forward and aft. The distributing or reversing valves are placed at the junction of the ahead and astern discharge pipe. The nozzles for propelling astern are above water and are protected by the belting. These are bronze castings bolted to the pump casings. They are square in cross section and the valve moves from side to side and directs the water into the ahead or astern pipes as desired. When placed in mid position dividing the stream the boat stands stationary. The design of the inlet is such that the water is conveyed to the pump without shock, and the cross section immersed areas of the hull in way of the inlet are so formed as to allow the water to enter the pump without disturbing the natural flow of the stream lines.

The weights of the vessel are:

	Tons of 2,240 lbs.
Huli	11.23
Fittings	1.77
Woodwork	1.61
Propelling machinery	7.89
Engineer's stores	0.33
Boatswain's stores	0.30
Fuel, crew, and passengers	6.95
Total	30.08

The metacentric heights with all weights and a full load of passengers is 1.77 ft. A series of trials was run with the "President Van Heel" to measure the I. H. P. required to drive the vessel at different speeds. The boat was brought to a draught of water corresponding with a displacement of 30.08 tons. The guaranteed speed of 8.5 knots was obtained with 123 I. H. P., the engines working at half power. With 246 I. H. P. the speed was 9.29 knots. Much power is wasted by hydraulic propeller when driven far above its designed speed. The object of providing such a large reserve of power in the boat was not that she might be driven at a greater speed than 8.5 knots, but to ensure that the power wanted for this speed might be obtained without difficulty under the arduous conditions of the service.

A Thornycroft water tube boiler of the "Speedy" type is fitted in the boat. The effective heating surface is 610 sq. ft. and the great area is 11.4 sq. ft. The steam pressure is 150 lbs. per sq. in. and the test pressure 300 lbs. The drums are of Siemens-Martin steel, 5-16 in. thick, increased to 9-16 in. at the tube plates. The tubes are of solid drawn steel 1 in. external dia., No. 14, B. W. G. thick. It was found that the boiler did not prime although the movements

of a vessel of this class are very violent when running in a sea way. Steam can be raised from cold water in 20 minutes. The boiler was fitted for burning both coal and oil fuel. It was first fitted with two "Holden" oil burners operated by steam. A 1 3-4 in. bore oil fuel main runs across the front of the boiler below the ash pit doors, and a 3-4 in. bore pipe is led up from this on either side to connect with the burners. A 3-8 in. bore steam pipe is led to each burner. The result

TRIALS OF THORNYCROFT BOILER FOR HYDRAULIC LIFEBOAT QUEEN.

		Oil Trials.					Coal Trials.		
Number of trial	1	2	3	4	5	6	1	2	3
Duration	65 min.	1¼ hours.	30 min.	30 min.	45 min.	45 min.	2 hours.	1 hour.	2¼ hours.
Atmospheric pressure	29.5" Mer.	29.63" Mer.	....	....	....	29.62" Mer.	29.61" Mer.	29.98" Mer.	29.84" Mer.
Air pressure in funnel	1.26" Wat.	1.35" Wat.	1.4" Wat.	....	1.97" Wat.	2.42" Wat.	1.52" Wat.	1.52" Wat.	2.13" Wat.
Air pressure in uptake	0.95" "	1.3" "	....	....	1.6" "	2.04" "	104" "	1.36" "	2.01" "
Boiler pressure	140 lbs.p.□"	142 lbs. □"	153.75 lbs. □"	152.5 lbs. □"	160 lbs. □"	156.0 lbs. □"	158 lbs. □"	128.4 lbs. □"	162.3 lbs. □"
Temperature of air	55.3° F	59.3° F	55.7° F	55.0° F	56.6° F	59.0° F	57.4° F	53.7° F	59.8° F
Temperature of feed water	51.2° F	51.5° F	50.5° F	50.0° F	51.3° F	51.0° F	50.22	52.2° F	56.4° F
Temperature of oil	109.3° F	153.1° F	150.2° F	97° F	88.75° F	61.1° F	....	....	....
Temperature of casing, front	145.4° F	....	....	....	....	....	152.7° F	129.6° F	107.1° F
Temperature of casing, side	87.0° F	....	....	....	....	....	89.3° F	68.4° F	100.8° F
Temperature of casing, back	132.6° F	....	....	....	....	....	134.8° F	129.8° F	128.6° F
Temperature in uptake	729° F	693.3° F	710° F	703.3° F	781.2° F.	671° F	787° F	728° F	787° F
Factor of evaporation	1.213	1.219	1.215	1.217	1.216	1.217	1.217	1.21	1.21
Total oil consumed	412.8 lbs.	443 lbs.	101.43 lbs.	111.39 lbs.	222.5 lbs.	175 lbs.	....	....	....
Oil consumed per hour	381 lbs.	354.4 lbs.	202.86 lbs.	222.78 lbs.	296.6 lbs.	233.3 lbs.	....	....	....
Oil per hour per sq ft of grate	33.4 lbs.	31.1 lbs.	17.7 lbs.	19.5 lbs.	26.01 lbs.	22.2 lbs.	....	....	....
Coal consumed with oil	129.9 lbs.	196 lbs.	84 lbs	112 lbs.	76.5 lbs.	141.0 lbs.	....	....	....
Total coal consumed	....	....	....	....	....	....	1,289 lbs.	536 lbs.	1,182 lbs.
Coal consumed per hour	120 lbs.	157 lbs.	168 lbs.	224 lbs.	102.0 lbs.	188 lbs.	644.5 lbs.	536 lbs.	524 lbs.
Coal per hour per sq. ft. of grate	....	....	....	....	....	....	56.55 lbs.	51.0 lbs.	50 lbs.
Total water evaporated	4,920 lbs.	4,095 lbs.	1,840 lbs.	1,660 lbs.	29.75 lbs.	3,065 lbs.	7,495 lbs.	3,650 lbs.	9,905 lbs.
Total water evaporated per hour	4,560 lbs.	3,276 lbs.	3,680 lbs.	3,320 lbs.	3,966.6 lbs.	4,086.8 lbs.	4,747.5 lbs.	3,650 lbs.	4,400 lbs.
Total water evaporated per hour, from and at 212° F.	5,531.28 lbs.	3,993.4 lbs.	4,471.2 lbs.	4,040.4 lbs.	4,823.3 lbs.	4,980 lbs.	5,770 lbs.	4,420 lbs.	5,320 lbs.
Water evaporated by coal	957.41 lbs.	1,442 lbs.	619 lbs.	825.4 lbs.	563.8 lbs.	1,039 lbs.	....	....	....
Water evaporated by oil	3,962.5 lbs.	2,653 lbs.	1,221 lbs.	834 56 lbs.	2,411.2 lbs.	2,026 lbs.	....	....	....
Water per lb. of oil	9.5 lbs.	598 lbs.	12.03 lbs.	7.4 lbs.	10.85 lbs.	11.56 lbs.	....	....	....
Water per lb. of oil, from and at 212° F.	11.52 lbs.	729 lbs.	14.60 lbs.	9.0 lbs.	13.17 lbs.	14.07 lbs.	....	....	....
Water per lb. of coal	....	....	....	....	....	....	7.37 lbs.	6.82 lbs.	8.4 lbs.
Water per lb. of coal from and at 212° F	....	....	....	....	....	....	8.97 lbs.	8.25 lbs.	10.17 lbs.
Water per hour per sq.ft effect heating surface	7.47 lbs.	5.37 lbs.	6.03 lbs.	5.44 lbs.	6.5 lbs.	6.72 lbs.	7.46 lbs.	5.98 lbs.	7.22 lbs.
Water per hour per sq. ft. of grate	400 lbs.	287.3 lbs.	322.8 lbs.	291.2 lbs.	347.9 lbs.	389.5 lbs.	399 lbs.	348 lbs.	419 lbs.
Horse power (water per hour 20)	228 hp.	163.8 hp.	184.0 hp.	166.0 hp.	198.33 hp	204.38 hp.	237.38 hp.	182.5 hp.	220 hp.
Grate area	11.4 sq. ft.	11.4 sq. ft.	11.4 sq. ft.	11.4 sq. ft.	11.4 sq. ft.	11.4 sq. ft.	11.4 sq. ft.	10.5 sq. ft.	10.5 sq. ft.
Effective heating surface	610 sq. ft.	6.10 sq. ft.	6.10 sq. ft.	610 sq. ft.	610 sq. ft.	610 sq. ft.	610 sq. ft.	610 sq. ft.	6.10 sq. ft.

given must not be taken as an exposition of the "Holden" oil burning system—the contractors simply using this particular burner to make their experiments with.

A great number of trials were made without taking measurements of fuel, etc., as it was necessary to make a number of preliminary trials with each of the different positions of burners, before the boiler could be made to work without making excessive smoke, which seems to depend on the relative position of the burner to the air admitted into the fire box, and whether it is admitted above or below the fire bars. Where the oil is burned in conjunction with the coal, it is found that if the greater part of the air is admitted above the fire bars, a smaller proportion of the coal will be burned, and there will be a greater tendency to smoke. On the other hand, by admitting a large proportion under the fire bars, the whole is more rapidly burned, and the consequent higher temperature causes a better combustion of the oil, and there is less tendency to smoke formation. Under these conditions a humming vibration is often set up, which vibrates the boiler casing, and is objectionable.

A series of tests were made with the furnace covered in with a brick arch, which when it reached a white heat effectually prevented smoke and gave the best result. It was found, however, that the large mass of brick took a long

time to get heated, which made the boiler so much slower at raising steam.

Trials were also made with the fire bars covered with pieces of broken brick, a small part being kept clear to light up with coal, which was also covered with brick when steam had been raised, and the boiler heated up. It was, however, found impossible to keep these oil burners going without the addition of some coal.

After completing the preliminary trials it was found that under the conditions necessary in this boat, one burner was sufficient when placed quite close to the surface of the coal.

The table gives the particulars of both the coal and oil trials when measurements were taken.

The boiler was steamed where finished in the yard without any special setting up. The feed water was pumped in with a duplex pump; the water being measured in tanks. The steam was blown off through the main stop valve. The draft was induced, or, in the case of the oil fuel, assisted by a steam jet in the funnel.

The coal used was Nixon steam navigation coal; on trials Nos. 1, 2 and 3 Astatki (flash point 310° F.) was used as liquid fuel, being heated by a steam coil to make it more fluid. On trial 4, 5 and 6 Wells' oil (flash point 195° F.) was used, not being heated before being injected into the furnace. The liquid fluid was brought into the furnace by "Holden" jets, steam being used for injecting the oil. In trial 1, two burners were used, being placed well apart, on trials 2, 3 and 4, one burner was used, placed in the center, on trials 5 and 6, two burners placed together in the center slightly diverging and pointing upwards were used. On trial 6 a brick arch 4 1-2 in. thick had been built into the furnace, with a clearance of 2 in. between it and the water tube arch. There were in the brick arch forty-five holes 3 in. by 2 1-2 in. giving a flue area of 338 sq. in. This arch reduced the grate area from 11.4 sq. ft. to 10.5 sq. ft.

The water evaporated by the coal in the oil trials was calculated for an evaporation of 7.37 lbs. of water per lb. of coal, as found from the first coal trial.

Nixon steam navigation coal was used on the coal trials. On trials 2 and 3 the brick arch, as described under oil trials, was used, but not, however, in trial 1.

The author gives the particulars of these trials, simply as a result of some experiments made, to find out the best and simplest means of using oil as an auxiliary on a lifeboat. The results must not be taken as those that can be obtained by the use of the Holden burner, as this would not be at all fair to that system; nor must they be taken as giving the maximum amount that can be evaporated using oil under such a boiler.

The author is indebted to the builders of the boat, J. I. Thornycroft & Co., for the particulars of the trials, and for the drawings of the boiler and the boat. Also to Sidney W. Barnaby, M. Inst. C.E., for the general description of the boat.

REPORT OF THE "MAINE" NAVAL COURT OF INQUIRY.

(Last installment.)

Commander James M. Forsyth, U.S.N., commandant of the Key West Naval Station, was called:

Q. When did the *Maine* coal here recently—since her coming down from the north?

A. Twice.

Q. What coal did she receive, and how much each time; the kind of coal, I mean?

A. She received anthracite coal, 280 tons at the first coaling, and I think 270 tons at the second. I have a memorandum of that.

Q. Refer to that paper.

A. This is taken from the log of the station; 280 tons at the first, and 271 tons at the last coaling.

Q. Can you give the dates of the coalings?

A. Yes, sir; the first was December 20 to 22, 1897, and the second January 18 and 19, 1898.

Q. Did she receive the coal from the pile which you have examined?

A. No, sir.

Q. What became of the coal that was in that pile at that time?

A. The coal that she received was mostly Morea coal from the Morea coal mine; anthracite Morea coal.

Q. That has all been given to ships?

A. It has all been given to ships. There may be a few tons of it left outside, on the eastern end, but I am not sure, because the two coals were mixed; but her main body of coal that she received was Morea coal. I would further say that she may have received some red-ash coal that was sent down later from the *Natalie*. There may have been some carloads of the *Natalie* coal; but the main body of her coal was Morea.

Charles Goodwin, foreman of the government machine shop at Key West, was also examined with reference to the coal stored there for naval ships.

Q. Did you, about the middle of February, receive an order from the commandant of this station to make an inspection of the coal pile for infernals?

A. I did, sir.

Q. Do you remember when you received the order?

A. I received it on last Saturday, a week ago.

Q. Did you carry out the order?

A. I did.

Q. In what way?

A. I had all the pile of coal turned directly over, so that I could see through every particle. I had two assistants with me, but I was there all the time myself. Not a particle of coal was left unturned over—of the anthracite coal, not the bituminous coal. There was bituminous coal there, too. Of the anthracite coal there was not a particle that was not turned thoroughly over, so that I could see through the whole of it.

Q. Was anything found wrong by anybody during this work?

A. Nothing at all.

Q. What did you expect to find?

A. I thought I might find some unforeseen bombs or something like that. That is what I expected. I found one piece of coal with a hole drilled through it, but that was nothing more than where they drilled to blast it. I was careful, of course, to see. I could tell pretty near the difference between the coal and any substance of iron or anything that way.

Q. You could have seen a bomb or a piece of pipe or anything of that sort?

A. Anything that way. I found one old tin can with some white lead in it. That might have dropped from the ship.

Chief Engineer Howell, of the "Maine," was recalled and his attention called to a large piece of cement which had fallen on the deck of the Ward liner City of Washington at the time of the explosion:

Q. Will you examine this piece of cement and identify it if you can?

A. I saw that piece of cement on the *City of Washington*, and now identify it as the same piece. My opinion is that it was blown from the *Maine*, and came from underneath the berth-deck blower on the port side.

Q. Upon what do you base your opinion?

A. That blower was not placed at right angles to the bulkhead on the forward side, and this piece of cement shows marks of an angle similar to the acute angle, which is the base of the blower.

Q. Is it not a very heavy piece of cement for the base of the blower?

A. I do not know exactly how this cement was, but I believe it was 2 1-2 inches thick, similar to this. I mean to say, I do not know how thick that cement was, but this piece is about 2 1-2 inches thick, and that is a very reasonable thickness to put either. The cement has also indications of oil on both sides of it, and I also know that that cement had oil on the under side, because I have seen oil drop through from that deck down into the bunker underneath. This cement showed oil on both sides while on the *City of Washington*. The marks of rivet heads on this cement and the imprint also of the angle iron and the running in line, similar to the acute angle I have spoken of before, which is also another indication that it came from the bottom of that blower. I should say that the top and bottom sides are parallel.

Gunner's Mate Schluter, who was engaged in the diving operations, was recalled before the court and asked:

Q. Have you been down diving since you gave your last testimony?

A. Yes, sir. I was down yesterday.

Q. Please tell to the court what you did and found.

A. I was dressed and lowered down by order of Mr. Powelson to look for boilers, if I could find them. While I was down, crawling down a little ways I found a boiler. I crawled all around it and all over it, and found it to be in good condition. Then, while I was on top of the boiler, I hit my helmet up against a plate overhead, and while crawling up on top of there I found a piece of wire. This wire looked to me not to belong to the ship, so I cut off a piece of it and sent it up on the line. After Mr. Powelson had inspected it, he called me up, and then sent me down again, telling me to saw off a piece of the wire and send it up. I went down again in the afternoon and tried to locate it, and did so after an hour or so. I tied the line to it and pulled in as much slack as I could, then sawed it off. Then I signaled for them to haul it up. They took it on board the *Fern* to Mr. Wainwright, who said it was telephotos wire.

Commander George A. Converse, of the U. S. S. Montgomery, who has seen thirty-six and a half years' service, and has made a special study of explosives, having had many years' experience in torpedo work, was called:

Q. Did you, while at the torpedo station, have many opportunities to witness the explosion of submarine mines?

A. Yes, sir; very frequent opportunities.

Q. What material—what explosives were used?

A. Gunpowder, nitroglycerin, dynamite, and gun cotton.

Q. What quantities of these materials have you seen used for such purposes at any one time?

A. The largest quantity I have ever seen used consisted of a torpedo containing 300 pounds of gunpowder and 200 pounds of dynamite, all in separate cases—100 pounds in each case—securely lashed together. Single charges of gunpowder of 150 pounds; charges of nitroglycerin of about 100 pounds; charges of dynamite of about 100 pounds, and charges of gun cotton of about 120 pounds.

(A plan of the forward magazine and shell room of the *Maine* was then shown to the witness.)

Q. Examine that blue print, Captain Converse, and tell the court if, in your opinion, one or more of those magazines should explode or partically explode in that ship would such an explosion lift the forward body of the ship partly out of the water?

A. I don't think it would lift the ship out of the water.

Q. Will you please give the court your reasons for thinking so?

A. I think that the body of the ship, water borne in all directions, would tend to offer a resistance which would cause a general effect of a large explosion to be exerted upward; and that an explosion tending to lift the ship up would necessarily have to be diffused over a very large surface.

Q. Suppose that a submarine mine explodes adjacent to the side or bottom of a ship thus water borne; what will be the direction of the explosion?

A. It exerts some effect in all directions, but the most violent effect in the direction of the least resistance, and that depends entirely upon the depth of the explosion below the surface of the water. I believe it to be possible to explode moderate charges of gunpowder against the sides of a strong ship and do very little damage, if the center of the charge is comparatively near the surface of the water; but if the center of the charge is well below the surface of the water, so that it will afford a large amount of water-tamping, then an injury will be done to the ship, while there will be comparatively little disturbance of the water at the surface.

Q. Supposing the charge to be a large one, and placed under the bottom of the ship where the water is only 8 or 10 feet below the bottom of the ship, what will be the direction of the explosion?

A. It would depend very much upon the position of the torpedo with regard to the bottom of the ship; that is to say, whether the torpedo was in close contact with the bottom, or was lying on the ground at some distance below the bottom of the ship, with water intervening. If the torpedo contained a large amount of explosive, and were placed in contact with the bottom of the ship, it is my opinion that it would endanger the ship by blowing a well-defined hole through it. The size of the hole depends, of course, upon the distance of the center of the charge from the skin of the ship. If, however, the charge is on the bottom of the harbor, and a depth of water of several feet intervened between it and the bottom of the ship, I think the tendency would be to lift the ship bodily; in other words, it would cause a large upheaval of water similar in effect to a large wave striking the ship, at a point directly over the mine—would tend to lift the body of the ship at that place exactly as the crest of a wave.

Q. In case of the explosion of a submarine mine under the bottom of a vessel, as you have described it, the effect upon a vessel, either in lifting her bodily, of blowing a hole in the bottom, would depend upon the size of the charge and its proximity to the bottom of the ship, would it not?

A. Yes, sir.

Q. If the charge is sufficiently large, and near enough to the bottom of the ship, both of these phenomena would take place—ship lifted up and the bottom blown in?

A. Yes, sir. A point to be taken into consideration is the nature of the explosives employed. Gunpowder is the more moderate explosive, and tends to produce a greater upheaval of water, as a rule, than do the more violent explosives, which, in proportion to their violence seem to cut a hole out of the water, lifting in the shape of a fine spray all that directly above the charge. To illustrate this point, and the injury sometimes done by high explosives, I cite the case of the *Aquidaban*, which, according to authentic photographs, had holes blown completely through from one side to the other by charges of gun cotton; whereas I have seen wooden vessels of comparatively good size, in which large quantities of gunpowder have been exploded, without injuring the vessel to any great extent, there being in the latter case simply a large upheaval of water, to which the vessel rose and fell exactly as she would have done in a heavy sea.

Q. What is your experience, Captain, in the case of the explosion of a submarine mine, as to what becomes of the mine; of the case itself?

A. I have rarely seen any considerable pieces of mine, whether they consisted of powder or of more violent explosives which have been found; they are almost invariably ruptured and lost.

Q. That is to say they are not blown up?

A. They are blown up. That is noticeable in the case of spar torpedoes, in which I have exploded gunpowder and gun cotton, in cases made of wood, cast iron, copper, and steel, and perhaps other metals. In all my experience I do not recollect to have seen any considerable pieces of any case after an explosion. Sometimes small fragments of cast iron have been seen, and, on one or two occasions, thrown into a boat, indicating a complete demolition of the case containing the explosive.

Q. In the case of a submarine mine that was exploded under the bottom of the ship, and containing sufficient explosive to completely destroy the ship in that region, would your remarks about the submarine mine case itself apply to the bottom of the ship which is submerged, not referring at all to the interior portion of the ship?

A. In the case of all mines the form of the mine is usually such as to contain only the amount of the explosives used, and hence there must be a rupture of the case for the gases to escape. Were the mine in contact with the ship, or quite close to it, I think the effect on the bottom of the ship would be—depending, of course, upon the size of the mine—to blow to pieces that part of the ship directly over the center of the explosion, and rending and tearing the bottom of the ship from the center in different directions, the amount of damage depending entirely upon the quantity and nature of the explosive employed. In other words, that the violent explosive would cut a hole, blowing that part that was cut out into small fragments, and that the size of the hole would depend entirely upon the size of the charge employed.

Q. Captain, will you please examine the sketches which have been shown you and tell the court whether, in your opinion, the explosion of one or all of these forward magazines, or their partial explosion, would leave the bottom of the ship in the condition which now exists, as represented in these sketches?

(Exhibit H was shown witness.)

A. The sketch might represent two explosions of entirely different natures. That part of the sketch represented here as frame 14 1-2 to frame 18 1-2, aft, in a direction of frame 23, might be produced by the explosion of a comparatively large mine of not violent explosive matter at some distance below the bottom of the ship; whereas the part abaft of frame 23 has all the appearance of the effect produced on iron plates by a high explosive in close proximity to it. There are in all explosions two general effects: First, the upheaval of the water, caused by the direct action of the explosion, followed almost immediately afterwards by the second upheaval of water and mud, being the reaction of the water from the sides and the bottom, which rushes in to fill the crater produced by the first explosion. But the location of this upheaval and the distortion of the keel in the present instance does not appear to have been formed by the secondary effect referred to above. It is too far forward; too remote. It is too far from the place marked "Débris," which must be somewhere about frame 27. If that is 27, then the distance, as marked, from frame 18, will be eleven frame spaces, or 44 feet forward of what would appear to be the crater of the most violent explosion.

Q. Then to what kind of an explosion do you attribute the force that caused this bending of plates and keel on sketch?

A. I am of the opinion that it could be produced by the explosion of a submarine mine containing a large amount of the lower explosives—gunpowder or similar—not in contact with the ship, but some distance below it, perhaps on the bottom.

Q. Looking at the sketch shown you, especially at that portion of the keel which has frame 18 on top, and the plates—bent plates—forward of it, excluding entirely all portion abaft of it, could this part which you are now told to consider have become so distorted from the effects of an internal explosion alone?

A. I do not think it could. I have never seen anything in my experience which would lead me to believe that it is possible to produce the effect indicated by any explosion within the interior of the ship in that immediate vicinity.

Q. Looking at the sketch shown you, and informing you that the forward 6-inch magazine and the fixed ammunition room were at that part of the keel which is represented as nearly vertical—that is, frame 18 to frame 24—could the conditions as shown forward of frame 24 have been caused by an explosion of those two magazines, or of any magazine abaft of frame 24?

A. I do not think it could.

Q. Do you think, then, necessarily, there must have been an under-water mine to produce these explosions?

Q. Indications are that an under-water explosion produce the conditions there.

Q. Looking at the plan of the *Maine's* forward 10-inch and 6-inch magazines, would it be possible for them to have exploded, torn out the ship's side on both sides, and leave that part of the ship forward of frame 18 so water borne as to raise the after portion of that part of the ship, drag it aft, and bring the vertical keel into the condition that you see on the sketch?

A. It is difficult for me to realize that that effect could have been produced by an explosion of the kind supposed.

Q. You said in your previous testimony that the distortion of the plates forward of frame 18 could have been caused by an outside mine of moderate explosive power. Could such a mine, if producing that effect, also set fire to the magazine?

A. I am unable to answer that question.

Q. Can you consider it possible, under any circumstances, to have a portion of the 6-inch magazine exploded and not all the powder in that magazine explode? If so, please state under what circumstances this would be possible.

A. I think I am positively certain an explosion might occur without exploding all the powder in separate tanks.

Q. But if the explosion originated on the inside of the magazine, without any water on the inside of it, would it not be almost certain that all the powder in that magazine would explode?

A. I think it would be much more certain.

Lieutenant Commander Wainwright recalled:

Q. Have you kept an account of the powder tanks that have been sent up out of the wreck of the *Maine*?

A. Only in my memory.

Q. Can you state to the court about how many have been sent up of each kind, and also their condition?

A. About thirty-five 6-inch and about ten 10-inch. I have seen one 10-inch tank and two 6-inch tanks that contained powder in bags, and the remainder were either empty and contained parts of excelsior packing or parts of powder bags. All the tanks were more or less injured, a large proportion opening lengthwise along the seam. Nearly all the tanks show signs of having been subjected to outside pressure, as if pressed against the powder inside; and their ends are also crushed in.

I saw two 6-inch tanks that were opened at the seams and were pressed down flat, as if by an exertion of considerable force. Those two have more the appearance of having been exploded, in my mind, than any other, and though not the appearance I would expect powder tanks to exhibit after a charge inside had burst. Others are not sufficiently destroyed to give me the impression of having been exploded, although I have never seen powder tanks after an explosion and can only draw my own dieas. The damage to the tanks seems to have been caused by contact with some hard object, and as the shells were found on top of these tanks accounts for the damage.

Q. How was the *Maine* made fast to her buoy at the time of her destruction?

A. Starboard bow chain.

Q. Do you know whether there was any private ammunition on board the *Maine*—that is, ammunition belonging to individuals and not to the Government?

A. None that came to my knowledge.

Much of the time of the court was taken up with examination of the several naval and wrecking company's divers who went down and reported the damage to the structure of the vessel. It was upon this information, of course, that the findings of the court were based, and consequently the results of these investigations made by the divers will be found concisely stated in the report of the court printed at the commencement of this article. (Commenced in May issue.)

Inspection Vessel at Buffalo.

Our illustration shows a very handy inspection vessel built for the United States Army Engineer's office at Buffalo by the Craig Ship Building Co., of Toledo, Ohio. She is built of steel on tug lines, and is 70 ft. long, 15 ft. 6 in. beam and is fitted with a compound engine, in dimensions, 12 in. and 22 in. by 16 in. stroke, and a Taylor water tube boiler built by the Detroit Screw Works. There is a commodious pilot house forward and a good sized cabin aft with passage all around. The boat will be used principally for use in superintending the work of breakwater construction at Buffalo. Major Thomas W. Symons, U. S. A., in charge of the Engineer Corps at Buffalo, advises us that the boat is very safe and fast and is satisfactory in all respects.

U. S. ARMY ENGINEERS' INSPECTION VESSEL AT BUFFALO, N. Y.

It is understood that the Government will soon commence a regular service of troop and supply ships between New York and Santiago de Cuba and Ponce, Porto Rico. The vessels for this service will probably be those recently purchased from the Atlantic Transport Line by the Government, and which were described in our August issue. A vessel will be dispatched from New York about every five days. The proposition is made that in addition to the War Department uses, these vessels shall carry mail matter for the Post Office Department. The ships which have been engaged as transports will be thoroughly overhauled and disinfected, and many special appliances, including distilling, ventilating and ice plants, will be installed before they are put on the route.

FORMER TRANSATLANTIC LINER ARIZONA NOW ON THE PACIFIC COAST.

As an illustration of the highly specialized types of steamships for different trades the renovation of the S. S. "Arizona" is an interesting case in point. Many of our readers will recognize in the picture of the two-funneled steamer the former Trans-Atlantic liner "Arizona," which in her days of triumph on the western ocean was probably the most talked of steamship afloat. To-day, if in her original condition, she would not be counted in the first class among trans-Atlantic liners, so great has been the increase in size, speed and accommodation in the nearly twenty years which have elapsed since she was built. But the S. S. "Arizona" that was has been transformed into one of the most modern and complete vessels sailing to any port in the far eastern trade. Through the courtesy of Messrs. Carlill, Dodwell & Co., the shipping agents of Tacoma, Wash., we are able to show the steamship as she now appears, equipped for service on the Pacific. A glance at the "before and after" views will show great changes in exterior appearance. Two funnels have been replaced by one, and in place of the old, heavy rig there are now four trim poles carrying triangular sails. There have also been some changes made in the upper works. Many would express a preference for the ship-shape appearance of the Guion liner "Arizona," though with her present rig and the former and less obtrusive smoke pipes she would probably look more symmetrical and yet strictly up to date.

When the now defunct Guion line brought out the "Arizona" for the New York-Liverpool trade there was consternation among its competitors. She was built by John Elder, at Govan on the Clyde, and was designed to show her heels to any liner afloat. On her trial trip she steamed at the rate of 17.3 knots, with 6,630 indicated horse power, and on her maiden voyage she covered the distance from Queenstown to New York in 7 days, 11 hours and 49 minutes. In subsequent voyages she reduced this time, and held the record until more powerful ships were put in service. Soon after she came out—November 7, 1879—she ran into an iceberg in mid-ocean and her bows were carried away. The forward bulkhead remained staunch, and the sudden stoppage of the vessel did not injure the machinery. She proceeded to St. John, N. F., and there temporary repairs were made, and subsequently, under her own steam, she recrossed the Atlantic and was permanently repaired at her builder's yard.

She is an iron vessel 464 ft. long, 45.2 ft. beam, and 35.7 ft. deep. Originally her load draught was 18 ft. 9 in., and her gross tonnage 5,164 tons. She is fitted with eleven bulkheads, eight of which are watertight and five are carried up to the upper deck as a protection from fire. For the Atlantic trade she had accommodation for 140 first-class passengers, 70 second-class, and permanent quarters for 140 steerage. Upon the lower deck accommodation for 1,000 steerage passengers could be arranged for. She had a single screw and compound engines of inverted type with three cylinders and three cranks. The high pressure cylinder was 62 in. dia., and this was set between the two low pressure cylinders, which were each 90 in. dia., all having a 5 ft. 6 in. stroke. At full speed she turned up 55 revolutions per minute. Her propeller was 23 ft. dia. and 33 ft. pitch.

There were six double-ended and one single-ended boilers, each 13 ft. 6 in. dia., and 18 ft. and 10 ft. long respectively. The total grate area was 780 sq. ft., and heating surface 19,500 sq. ft. The working pressure was 90 lbs. per sq. in., and the daily coal consumption was 125 tons.

She is a good model, her block co-efficient being .589 and her midship co-efficient, .895. After the Guion line went out of existence the "Arizona" lay idle for several years, until the present year, when she was sold for service on the Pacific coast. She was sent to her builder's yard (now the Fairfield Company), and left there in March in the condition the recent photograph shows. She was put in commission by the Northern Pacific Steamship Company and later sold to the Northern Pacific Railway Company, which company placed her at the disposal of the United States Government for carrying troops to the Philippines.

The changes made in the interior arrangements of the vessel were extensive. Her passenger accommodation was, of course, much too extensive for trade on the Pacific; consequently she was rearranged to carry 40 first-class passengers amidships and 1,000 steerage passengers below. The intermediate passenger quarters were entirely removed and the additional space available gave opportunity to make the cabin accommodation unusually spacious and airy. Her holds are now arranged for carrying tea, of which 6,100 tons measurement could be stored away, and there is also a lead lined chamber provided for transport of silk, which is very profitable freight. New machinery was fitted with triple expansion engines and new boilers built to carry the additional pressure. The rate of speed maintained in the transatlantic trade was not necessary on the Pacific route, so less power was fitted, and on her trial trip this spring she averaged 15 5-8 knots. A very complete equipment of auxiliary machinery and deck appliances was supplied, and should the Arizona be again put in the Pacific passenger trade she will likely prove as popular a vessel as she was on the Atlantic several years ago.

The Polynesian Steamship Co. has been incorporated under the laws of New Jersey to establish a line of steamships from San Francisco to Honolulu, the Philippine Islands and Tahiti. The capital stock is $1,500,000. The incorporators are C. R. Flint, R. A. Smith, B. Hatch, and W. M. Ivins, of New York, and others.

GUION LINER ARIZONA WHEN SHE HELD THE ATLANTIC RECORD.

S.S. ARIZONA AS SHE NOW APPEARS—A PACIFIC LINER.

IMPROVED APPARATUS.

Asbestos Air-Cell Fire Board.

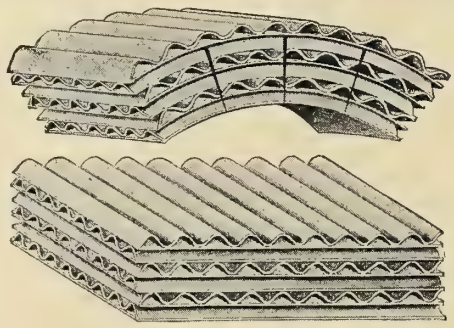
Strong claims are made for the efficiency of the asbestos air-cell fire board by the manufacturers, who recently caused a series of tests to be carried out. A pine board covered with various materials, the asbestos board included, was exposed to the blast of hot gases. The temperature of the gases striking the protecting material was around 4,000 deg. F. With a coating of varnish 1-50 in. thick the board ignited in 1-3 second; with a protection of 1-20 in. of sheet iron, the board ignited in 15 seconds, and with 1-4 in. to 1 in. of asbestos board, the time of ignition varied from 7 minutes to 60 minutes. This board is sent out from the factory flat, and can readily be bent to shape for boiler coverings or for use in structural shipwork as an insulating material. It is also made in the form of sectional covering or air-cell lagging for covering pipes. These coverings are manufactured by the Asbestos Manufacturing Co., 291 Douglass street, Brooklyn, N. Y.

Knorr-Norris Course Indicator.

The Knorr-Norris Course Indicator is a simple device for lightening the labor of the navigator recently put forth by Theodore Alteneder & Sons, Philadelphia. On a heavy square card is printed a circle marked with the points of the compass over the degrees of the circle. Above it is a round card, marked in the same way which revolves around a center. The center is of glass and in it is fastened a string. The instrument is used instead of parallel rulers in finding the courses and bearings on charts, being easier and more accurate. It gives, at the same time, true and compass bearings, and prevents mistakes in the application of the variation of the compass. The lower card represents the chart and has lines on the edges by which it may be accurately placed on the meridian. The upper card represents the compass. In use on Mercator's Charts the card is placed on the chart with the center over the position of the ship and adjusted to the meridian by the marks on the edges. The upper card is adjusted to the variation of the compass. The string is stretched to the point to which the course is directed and indicates on the upper card the compass course and on the lower card the true bearing. On charts of conic projection the indicator is adjusted to the parallels always over the position of the ship and will show the bearing of any point. The indicator may also be used as a cyclone card to find the bearing of the center of the storm. This indicator is copyrighted by Thaddeus Norris.

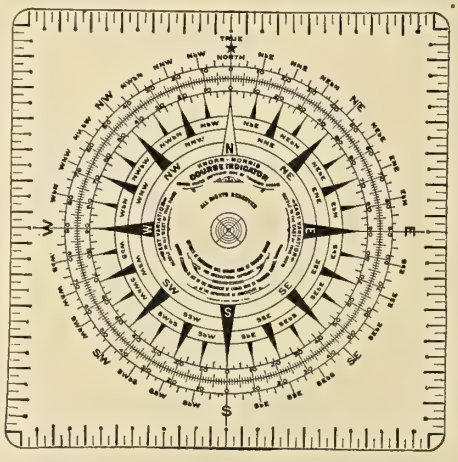
Regal Flexible Metallic Packing.

A novel style of packing which the manufacturers style "metallic" is shown in the illustrations herewith. It consists of a composition of "metal and graphite" in granular form encased in thin plaited cotton tubing. This lubricating element in composition with the metal is said to insure permanent and perfect lubrication, resulting in a reduction of the friction and wear of the rods. The grains of this packing are very irregular in shape. The metal used is of medium hardness so as to stand any class of work, and is



FORMS OF ASBESTOS FIREBOARD.

thoroughly impregnated with the lubricating element, graphite. The metal is so compounded that the expansion and contraction due to varying temperatures is almost imperceptible, and the point of fusibility is much greater than the temperature of superheated steam at any pressure. The packing is placed in the stuffing box in the ordinary manner—breaking joints with each ring and compressing with the gland. The grains do not solidify; they simply pack very tight and close together; but each grain remains separate and distinct from every other, thus making it easy to overcome any leakage that may result in time by slight compressions and allowing the easy removal of the packing from the stuffing boxes in case the engine is overhauled. The thin cotton tubing, which is next the rod



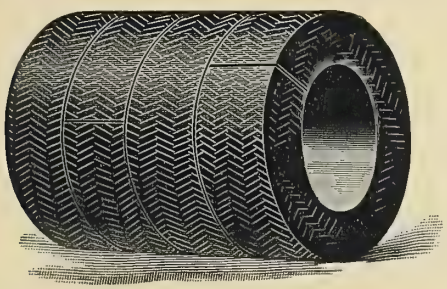
KNORR-NORRIS COURSE INDICATOR.

when the stuffing box is packed, wears off in a few hours' time, leaving a highly polished and perfectly lubricated surface in contact with the rod, as shown in the illustration. Should the packing ever be removed from the stuffing boxes it will be found to come out as easily as it was

put in, and will readily crumble back into its original granular form, and can be put in new tubes, ready to be used again. It is applied in the ordinary stuffing boxes without alterations or disconnections, and the manufacturers assert there is no tendency to cut or wear the rods. It is made in all sizes by the Regal Packing Co., Fisher Building, Chicago, Ill.

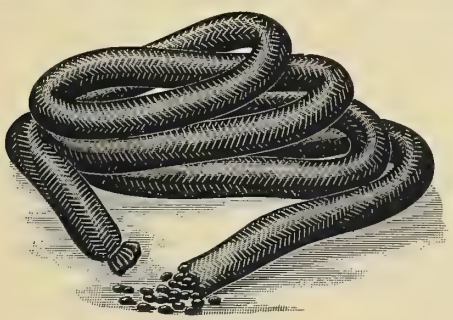
Bausch & Lomb-Zeiss Binoculars.

Scientific research which has made possible the modern improvements in engine construction and electrical apparatus, for examples, has also been the cause of a great advancement in the construction of optical instruments. The Bausch & Lomb-Zeiss stereo field glass is the most important application of these discoveries to marine work. Unless a person has tested one of these binoculars it is difficult to clearly state the tremendous improvement over the old forms. In the sectional view of the glass here published the peculiar arrangement of prisms will be noticed. By using double reflecting prisms the



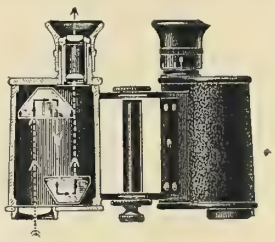
REGAL PACKING AFTER COMPRESSION.

image formed by the object lens is inverted and brought to a focus much closer to the object glass than would be possible without it. It is a well-recognized fact that in order to obtain good optical results an object lens of comparatively long focus must be used in any telescope. In the ordinary forms this long-focus object glass produces an inconveniently long instrument.



REGAL PACKING READY FOR USE.

The inverted image formed by the object glass of the ordinary telescope has to be viewed either with a concave eyepiece, which results either in poor definition or a small angular field, or with the terrestrial eyepiece, which in this case is extremely long and thus increases the length of the telescope unduly. Furthermore, the terrestrial eyepiece, if made short enough to be useful at all on a hand glass, gives more magnifying power than is desirable, and has an angular field no greater than that of the concave eyepiece. The reinversion formed by the object lens, by means of a double refracting prism, makes it possible to use



BAUSCH & LOMB MARINE GLASS.

the celestial eyepiece. This not only has a much greater angular field, but a much flatter field, as well, and has a greater light transmitting power. The angular field of the best Galilean and terrestrial telescopes heretofore constructed was not over 2 deg. in the powers of 6 dia. or above, whereas the 6-power of the glass here described has an angular field of 9 deg. This feature makes the stereo field glass extremely valuable for marine work, as a large horizon can be scanned without changing position of the observer or of the eyes, and furthermore, the emerging beam of light from the eyepieces is so calculated that the eye takes in the whole of the field without shifting from one edge of the eye lens to the other, and the field is equally distinct at the edge and in the center. The placing of the object lenses farther apart than the eyepieces are is also a great advantage for marine work, as it gives a stereoscopic solidity to distant objects, which makes them stand out appreciably from other objects in the same line of vision. It is a fact familiar to users of the ordinary binocular field glasses that objects near the limit of vision, with the glass, appear to be bound together by a sort of indistinct haze, which prevents the seeing of details clearly or the recognition of the exact forms of the objects. In the stereo field-glasses the increased distance between the field-lenses gives a much greater parallax and eliminates this indistinctness; hence, with a stereo field glass objects can be seen farther and more distinctly than with an ordinary binocular of the same magnifying power. These optical advantages combined with the extreme lightness and compactness of the construction make it a specially desirable glass for marine use. The glass out of which the prisms are formed is a special glass made on purpose for this use. It is almost of the hardness of rock crystal and of extreme transparency and brilliancy. This is necessary in order that the prisms may not tarnish after long exposure to the air, and may not decrease in any way the volume of light entering the glass through the field-lenses.

MARINE ENGINEERING

PUBLISHED MONTHLY

BY THE

MARINE PUBLISHING COMPANY,

World Building New York.

H. M. SWETLAND, President and General Manager.
H. L. ALDRICH, Vice-President and Business Manager.
A. B. SWETLAND, Treasurer.
H. F. DONALDSON, Secretary and Editor.

Southern Representative.

S. W. ANNESS, Philadelphia, Pa., Machinery Dept., The Bourse.

Western Representatives.

L. L. CLINE, Detroit, Mich., 47 Hodges Building.
B. M. GARDNER, Chicago, Ill., 1522 Monadnock Block.

Traveling Representatives.

E. L. BLANCHARD. A. B. FLETCHER.

SUBSCRIPTION:

Domestic, $2.00. Foreign, $2.50. Single Copies, 20 cents.

Entered at New York Post Office as second-class matter.

THERE is a wide-spread belief in shipping circles that a great expansion of trade in home bottoms will follow the signing of a treaty of peace. Not only will the former Spanish possessions in the West Indies be under the control of the United States, but some form of proprietorship in the Philippines will give an advantage to American shippers, from home ports at least. Then trade with Hawaii will undoubtedly show a rapid development, especially when the country again directs its energy to peaceful pursuits. The trade which has been carried on at the various ports in these countries in recent times is consequently a subject of the greatest present interest. The most recent and accurate statistics obtainable are those contained in the Review of the World's Commerce for the years 1896-97, just issued by the Bureau of Foreign Commerce of the Department of State at Washington. From this we shall give a few totals which will be instructive. Porto Rico is about the same length as Long Island, but nearly eight times as wide. There are about 150 miles of good roads inland, nearly 500 miles of telegraph line, and 300 miles of railroad built or building. The most recent figures of imports and exports available are those for 1895, which show a total value of imports of $16,155,056 and exports of $14,629,494. These figures are a good deal less than the totals for 1894. Of the imports, rice of the value of $2,180,004 was the principal item. Next meats and fish aggregated about $2,800,000. Other items in excess of $100,000 in value, were coal, iron, soap, flour, vegetables, olive oil, wine, cheese, and provisions. Every one of these items could be readily filled from here. The exports were: Coffee, $8,789,788; tobacco, $646,556; sugar, $3,747,891, and honey, $517,746. Of the articles imported, the United States led with coal, petroleum and wood, but most of the manufactured goods came from Europe. The machinery used in the island was imported almost exclusively from Great Britain and Germany, a condition of affairs which ought not to last many months longer. In 1897 the trade of the United States with Porto Rico reached, in imports, $2,181,024, and exports, $1,988,888. In the year 1896 the total weight of the principal exports from the island was 96,838 tons, more than half of which was sugar. The Philippine Islands, according to the commercial reports, afford great opportunities. For risky, though very profitable investment, they now present a fertile field. In 1896 the imports into the islands were valued at $10,631,250, and the exports at $20,175,000. About 13 per cent of the imports came from Spain, and about 50 per cent of the exports went to the United States. The chief exports from the islands to this country were hemp and cane sugar, with much smaller amounts of vegetable fiber and straw goods. Although there are about 8,000,000 natives and 25,000 Europeans in the islands there are only 123 miles of railroad, running from Manila to Dagupin, in operation. English locomotives are now used. There is a monthly service of Spanish steamers between Manila and Liverpool, several lines to Hong Kong, and many coast lines between Manila and the other ports on the islands. Cuban trade is, of course, a more familiar subject, but it is appropriate here to reproduce a few facts concerning the island. In area it is about the size of the state of Pennsylvania. The imports of Cuba during the fiscal year ending April, 1896, were valued at $66,166,744, and the exports at $94,395,536. Official figures of the trade of the United States with Cuba in 1893 show imports valued at $78,706,506, and exports at $24,157,698. In 1897 these figures had dropped down to $18,406,815 and $8,259,776 re-

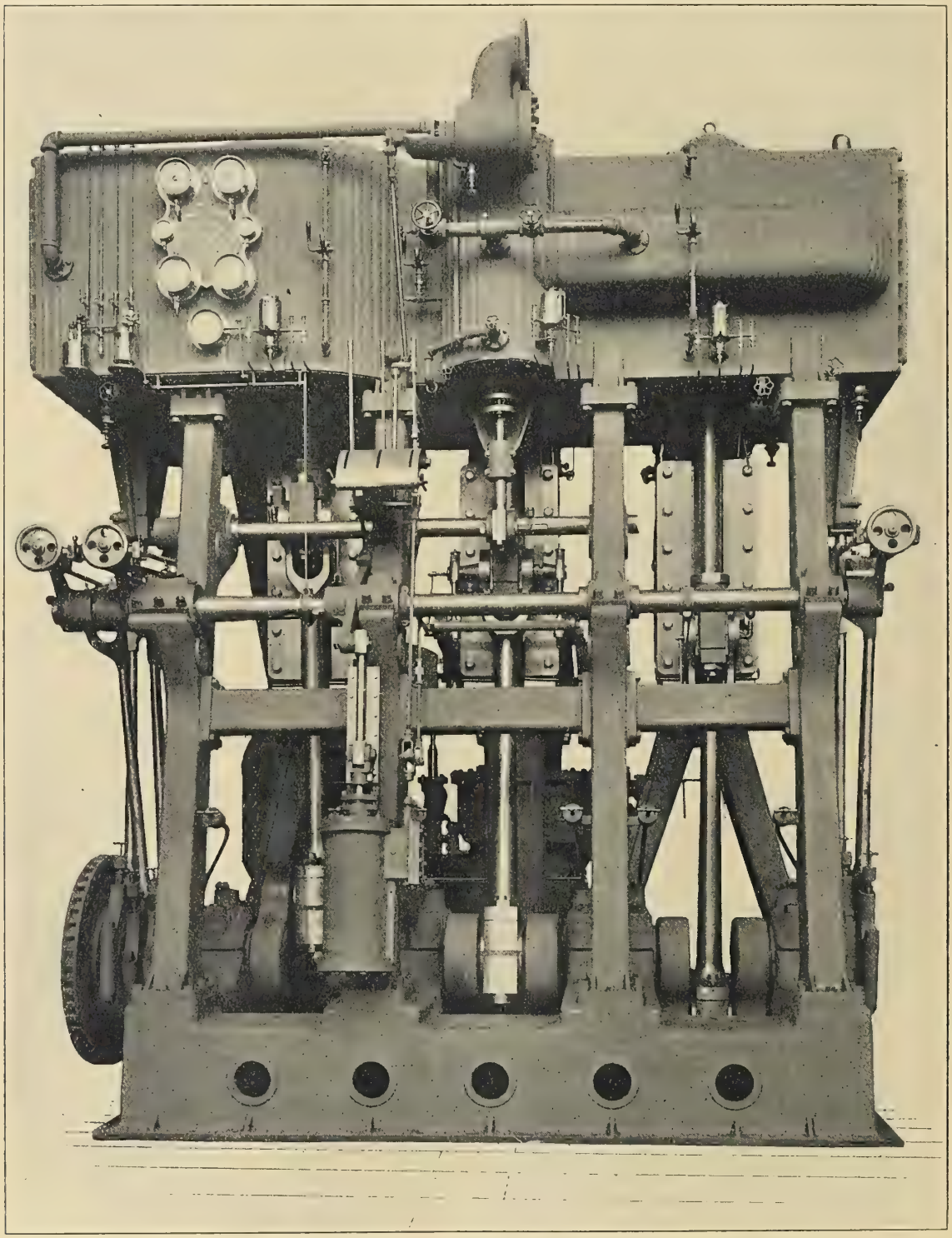
spectively. The commerce of Spain with Cuba in 1896 was: Imports from Cuba, $4,257,360, and exports to Cuba, $26,145,800. Besides the tremendously valuable tobacco and sugar crops of Cuba she has a considerable mineral wealth, which is imperfectly developed. The chief imports are cereals, meat products and manufactured goods, all of which needs could best be filled by this country. The railroad development includes about 1,000 miles of main lines owned by various small companies. In general the country is as backward as might be expected under Spanish rule. Trade with Hawaii is at present largely in the hands of the United States. In 1896 we took 99.64 per cent of her exports and sold her 76.27 per cent of all imports. The total value of Hawaiian exports in 1896 was $15,515,230, and imports $7,164,561. In their order of value the exports ranked, sugar, rice, bananas, wool, coffee, hides. At the present time Hawaii imports "almost everything she uses," the attention of the islanders being chiefly taken up with the raising of sugar.

RULES and regulations for the Paris Exposition of 1900 have just been issued from the office of the Commissioner-General of the United States, at Chicago. The Exposition will open April 15 and close November 5. In addition to the Exposition proper there will be a retrospective Centennial Exposition arranged among the different classes, and which will endeavor to display the progress in various branches of production since the beginning of this century. There will be also various intellectual competitions and congresses held, the details of which have not yet been announced. As might be expected, the General Classification, which covers almost every form an exhibit might take, is very extensive, and under the head of Civil Engineering-Transportation there is a subdivision (Group IV, Class 33) which is styled "Equipment for Mercantile Navigation." This in detail covers a very wide range of theoretical and practical work, from raw materials to finished models of ocean steamers. We have no doubt the shipbuilding and allied interests of this country will take this opportunity of showing the real position of America, in its actualities and possibilities. The whole civilized world has had a wonderful exposition lately of the efficiency of a home-made American ironclad navy. In 1900 there will be an opportunity to show the world what our builders can do in the construction of vessels for the contests of peace. A splendid showing could be made by the shipbuilding interests, if not as individuals then as a unit, in a grand display of models. The American liner, the Great Lake freighter, the Sound steamer, the Mississippi stern-wheeler, and the whaleback are some of the typical boats. There is no better reason now why ships should be built in Europe for America than in America for Europe or any other place, no matter how remote, where a customer exists. The material men, engine builders, and manufacturers of the various auxiliary and deck appliances for ships would also find it to their interests to be represented. Already they are ahead of the builders in booking foreign orders. This would be a fit matter for the Society of Naval Architects and Marine Engineers to discuss at its forthcoming meeting.

CONTINUAL reports of the wretchedly insanitary condition of army transports returning from Cuba with sick and invalided soldiers calls attention to this peculiarity of vessel construction, or, shall we say, marine life. The condition on the transports is only an exaggeration of what occurs in miniature on many a vessel in every-day trade. A vessel is the last place in the world for a sick man. It would seem, generally, indeed, that ships were built to be inhabited by men of rude health, and that there is no duty for the sick man to do except die. A very interesting investigation along these lines has been made by Dr. A. Wellesley Harris, the medical officer at the port of Southampton, England. This is a port of call for as crack a lot of passenger ships, engaged in various trades, as could be found anywhere, and a splendid station for observing the best in the way of hospital accommodation aboard ship. After an inspection of twenty-eight such vessels he finds there is a necessity for great improvement in these matters: Situation and surroundings of the hospitals; cubic capacity provided for each patient; ventilation and lighting of the hospital; lavatory accommodation; proportion of berths to crew and passengers. His recommendations include: Location of hospital on the poop deck, with separate lavatory; means of isolating two separate varieties of infectious disease, and provision for separating the sexes; air space to each berth not less than 200 cubic feet, with proper inlets and outlets.

SMASHUP OF THE ENGINE OF THE LAKE PASSENGER STEAMER MANITOU.

A serious smashup of the engines of the steamer Manitou of the Lake Michigan and Lake Superior Transportation Line occurred early in the morning of August 6. The vessel was on one of her regular passenger trips bound from Mackinac to Chicago. When about twelve miles south of Point Betsey and four miles from land a bolt in the low-pressure connections of the engine broke, and in a few seconds the engine was a wreck. Fortunately, the steam mains were not ruptured, and Chief Engineer Peck and his assistants promptly shut the boiler stop valves. When the break occurred the steam barge Algonquin was close to the Manitou, and an agreement was made for a



TRIPLE-EXPANSION ENGINE OF THE LAKE MICHIGAN PASSENGER STEAMSHIP MANITOU.

tow, the Algonquin taking the disabled steamer into Manistee, where a number of the passengers took train for Chicago. Subsequently the Algonquin towed the Manitou to South Chicago, where repairs are now being executed by the Chicago Shipbuilding Co.

By reference to the engraving of the engine of the Manitou a clear conception of the nature of the mishap can be had. The engine is of a design which is very popular on the lakes, with staggered frames and slipper guides. The cylinders are 23 in., 38 in., and 62 in. by 36 in. stroke. Stephenson link motion is used, the eccentrics for the intermediate and low pressure motions being placed outside the frame at the after end of the crank shaft. Motion is communicatd to the intermediate valve, which is of the piston type, by a rock shaft. This permits the valve to be placed outside the center line of the engine, giving greater compactness and reducing the fore and aft length of the engine. The engine was fitted with the high-pressure cylinder forward, and the starting platform on the starboard side. Each connecting rod has a forked end with a fixed pin working in a bearing in the crosshead. The smashup started by the breaking of the inside binder bolt on tne low-pressure crosshead. This sheared off cleanly at the cap, the nut and screwed end of the bolt dropping down into the crank pit. On the next up stroke the piston rod and crosshead pulled away from the connecting rod, the remaining bolt giving way under the excessive strain. The piston kept on upward and the nut which secured the rod to the piston went through the low-pressure cover. This bent the rod, cockbilled the piston and split open the cylinder. Meanwhile the connecting rod had fallen outwards and wiped away two of the front columns, to one of which the starting engine was bolted. The crosshead cap with a short length of bolt, and one of the nuts in place fell into the crank pit. The thickness of this piece being greater than the clearance between the crank webs and the bed plate, the low-pressure crank was lifted, breaking the bed plate in two places, at the after main bearings. The weight shaft and many of the rods were badly bent, but no other serious fractures occurred. The bolt which broke in the first instance was of steel, 3 in. dia. It will be necessary to remove the engine and replace a considerable portion of it, the expenses of repairs being estimated at $30,000.

The Manitou is one of the best known passenger steamers on the Great Lakes. The contract for her construction was let in 1893 to the Chicago Shipbuilding Co., where her hull was built. The company at that time did not build engines, and so these were turned out of the shops of the Cleveland Shipbuilding Co. Her general dimensions are: Length, 275 ft.; beam, 42 ft.; depth, 24 ft. 6 in., and gross tonnage 2,945 tons. Her speed in regular service has been about 17 miles an hour. She has seen an amount of hard service in the several seasons since she came out. Her schedule called for three trips weekly between Chicago and Mackinac Island, a distance of 340 miles, between the dates of June 15 and September 15. She is a two-deck steel ship, fitted with seven bulkheads, and was built specially for passenger traffic, having 125 staterooms on board.

A serious mishap occurred to the lake side-wheel steamer Greyhound, August 19. She had left her wharf in Detroit with a picnic party, and had reached a point about two miles below the St. Clair canal, when apparently without any warning one of the main rods of the engine broke, and the engine was speedily wrecked. The damaged vessel is owned by the Star-Cole line, and it was only a few months ago she was extensively overhauled and had a considerable amount of repairs made to her machinery. Her engine is of the walking beam type, with cylinder 60 in. dia. and 12 ft. stroke. The connecting rod broke squarely across about 4 ft. from the crank end.

CORRESPONDENCE.

Against Favoritism in Naval Promotions.

Much has been very properly written and said of the injustice in promoting Commodore Sampson over Commodore Schley, but I have not seen a protest against the injustice of only advancing the chief engineers of the "Oregon" and other U. S. naval vessels three and two numbers, while the captains were advanced six and five.

Commodore Schley, Captain Clark and other commanders recognized how much was due to the Engineers' Department for the fine records made by the ships, and while every one is pleased over the promotions of the captains, the writer, with many others, think that the engineers have not received the proper recognition for services equally well and gallantly performed. I trust when the subject is presented to Congress that something will be done to show the Nation's appreciation of the heroism "below the protective deck." RANDOLPH BRANDT.

Bids for U. S. Boats and Destroyers.

Bids for the twelve torpedo boats and sixteen torpedo-boat destroyers, recently described in these columns, were opened at the Navy Department, Washington, August 23. There were twenty-eight bids in all, some of which are as follows:

Bath Iron Works, Bath, Me.—Two boats, class 2, 29 1-2 knots, $161,000 each; four, $160,000 each; one destroyer, 400 tons, 29 1-2 knots, $292,000; two, $281,000 each; three, $280,500 each.

Columbian Iron Works and Dry Dock Company, Baltimore, Md.—One, two, three or four boats, 165 tons, 26 knots, $160,000 each. Class 2—One at $168,000; two, $165,000 each; three, $163,000 each; four, $161,000 each; same dimensions and speed. One destroyer, 28 knots, $293,000; two at $291,000; three, four or five, $289,000 each. Class 2, 28 knots, 420 tons—One or two, $282,500 each; three, four or five, $282,000 each.

Dialogue & Sons, Camden, N. J.—One destroyer, 29 knots, $293,000; two, $285,000 each.

Gas Engine and Power Company, Morris Heights, New York—One destroyer, 420 tons, $285,000; one destroyer, 420 tons, 29 knots, and one boat, 170 tons, 26 1-2 knots, $428,000; two destroyers and one boat, $708,000; two destroyers and two boats, $849,000; two destroyers and three boats, $987,000.

Harlan & Hollingsworth Company, Wilmington, Del.—Destroyer, 408 tons, 29 knots, $294,000; two, $291,000 each.

Lawley, George, & Sons, South Boston—Boats, 165 tons, 26 knots, one, $162,900; two, $159,400 each; Class 2—26 1-2 knots, one, $152,900; two, $149,400 each; Class 2 (another design), one, $157,400; two, $153,900 each.

Maryland Steel Company, Sparrows Point, Baltimore, Md.—$286,000 each; three of different specifications, $283,000 each; four, $282,000 each.

Neafie & Levy, Philadelphia, Pa.—Destroyers, 420 tons, 29 knots—One or two, $284,000 each; three, $283,000 each.

Nixon, Lewis, Elizabethport, N. J.—Boat, class 2, 26 knots, one, $168,000; two, $165,000 each.

Trigg, William R., Richmond, Va.—One boat, 150 tons, 26 knots, $160,000; two, $150,000 each; three, $129,750 each; four, $119,750 each. In a letter filed subsequently to the bid for torpedo boats, making no mention of size or speed, Mr. Trigg proposed to build one for $275,000; two, $260,000 each; three, $250,000 each; four, $240,000 each; five, $233,000 each.

Union Iron Works, San Francisco, Cal.—Destroyers, 400 tons, 29 knots, one $294,000; two or three, $285,000 each; destroyers, second class, same dimensions and speed, one, $294,000; two, $282,000 each; three, $281,500 each.

Wellington, Frank O., & Co., Fore River Engine Company, Weymouth, Mass.—Destroyer, 400 tons, 30 knots, and boat, 164 tons, 28 knots, $160,000 each; three, $159,000 each. This bidder varied the time of completing the boats and destroyers from ten to eighteen months.

Wolf & Zwicker, Portland, Ore.—One boat, 150 tons, 26 knots, $176,000; two, $165.000 each; three, $163,400 each; four, $162,500 each. Class 2—Destroyer, 420 tons, 29 1-4 knots, $289,000; two, $285,000 each; three, $282,000 each; one of 28 knots, $285,000; two, $291,000 each; three, $289,000 each.

The bids were chiefly made on department plans and where special bids were made on the bidder's own designs they are designated under the style of "Class 2" in the foregoing. After the opening of bids a representative of the Herreshoffs, of Bristol, R. I., put in a bid for two boats of 168 tons and 28 1-2 knots speed for $166,000 each. Mr. Trigg is connected with the Richmond Locomotive Works, which built the machinery of the Texas. Several prominent concerns, including builders of former torpedo-boats, did not submit any bids.

EDUCATIONAL.

ELECTRICITY ON BOARD SHIP, PRINCIPLES AND PRACTICE.—XII.

BY WM. BAXTER, JR.

Having fully considered the construction and the principles of operation of electric generators, the next matter which concerns us is the manner in which the currents generated are conveyed to the apparatus in which they are utilized. It will be evident at once that this can be accomplished by means of the crudest devices, and this was actually done in the early days of electric lighting. If we had a boiler and an engine, located in the same building, we could operate the latter if we connected it with the former by means of a line of piping, and carried the exhaust away in the same manner; but it is evident that it would be a convenience to locate a valve at some point in the steam pipe, for without this the engine could not be stopped without blowing off the steam in the boiler. It is further quite clear that the position in which the valve were placed would largely determine its usefulness. If we had a number of engines, and these were supplied with steam by a number of boilers, the efficiency of operation of the plant would be increased if the connections between the engines and boilers were such that all or any number of the engines or boilers could be used at once and if any boiler could feed directly into any engine. To accomplish all this it would be necessary to run the piping in some systematic manner, and to locate valves of various kinds at points where through them the currents of steam could be controlled. The most perfect system of piping for this purpose would be the one that would facilitate to the greatest extent the future operation of the plant. A steam engine set up in the woods to run a sawmill is piped in any way that the conveniences at hand render practicable; on the other hand the piping system of a modern first-class ship is worked out with very great care, and every part is arranged so as to save space and to be in the most convenient position.

The connection of electric generators with the apparatus to which the current is supplied presents a case as nearly parallel to that described in the foregoing as the difference between steam and electric distribution will permit. In the case of steam the boilers are placed as near to the engines as practicable, while with electricity the distance between the generators and the apparatus operated thereby is generally, comparatively, very great. On this account the connections from the generator or generators are brought to a common point, and from here the distribution wires are led off. If we have a single generator its connection with the distributing circuits can be represented in its crudest form by the diagram Fig. 61, while Fig. 62 will serve to represent the connections when two generators are used. In Fig. 61 it will be seen that there are several devices in addition to the generator proper, thus there is the field regulating rheostat, marked *R*, whose office has already been explained, but we may repeat here that it is for the purpose of regulating the pressure or voltage of the current. The device shown at *b* is a fuse, which is a safety device, to open the circuit when the current becomes so great as to be liable to burn out the generator armature. *Am.* is an instrument used to measure the strength of the current and is called an ammeter. *J* is an electro magnetic device for opening the circuit when the current becomes too strong, and is known as a circuit breaker. It serves the same purpose as the fuse, but its action is such that it responds to instantaneous increases in current, while the fuse only acts with excessive currents of some duration. Either device alone can be used, but for reasons that will be given hereafter it is better to employ both. *V* is a volt meter, and is to electricity what the steam gauge is to steam, or any other medium acting under pressure. The current passing through this volt meter is taken from the points *m n* and thus has the full pressure of the generator. It can also be drawn from the points *m v*, as indicated by the wire *w*, and then it will show what voltage acts directly upon the external circuit.

The connections from the generator, after passing through the various devices, reach the points *c c*,

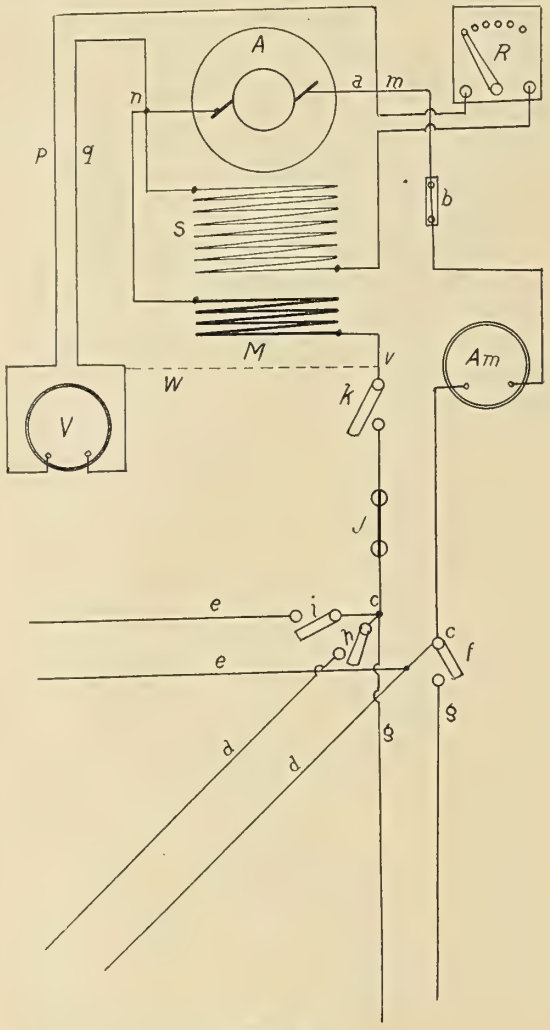


Fig. 61.

from which the external circuits are led off. The current flowing in the branch *g g* can be cut off by opening the switch *f*, and in the same way the currents in branches *d d* and *e e* can be controlled by switches *h* and *i* respectively.

In examining Fig. 62 it will be noticed that the connections are the same as in Fig. 61, except that the ammeter is placed in the wire leading from the magnet coil *M*, while the switch *k*, which is used for the purpose of opening the main circuit, is in the wire leading from the armature. From this it will be understood that it makes no difference on which wire the ammeter is placed so long as it is in the main line, for the current is of the same strength at all points. Another difference is that only one volt meter is used, and this is so arranged that by throwing the switch *s* to one side or the other it can be connected with the generator to the right or the one to the left, thus it can be used to measure

the pressure of the two machines, but not both at the same time. It is not really necessary to have a voltmeter in service all the time, and frequently they are not so used. An instrument that can be kept in circuit continuously costs more than one that can only be left in service for a few seconds, therefore the latter kind are often used for the sake of economy, but this practice is generally confined to small plants.

From a study of these two diagrams it can be seen that so far as the operation of the apparatus is concerned it is wholly immaterial where the various parts of the system are located so long as they are in the proper relation to each other; thus if the generators were in a small room the rheostats *R* could be placed upon one of the walls and the volt and ammeters upon another, while the several switches could occupy positions on all the walls. The wires connecting one with the other could also be run in any convenient or desired manner, but as in the case of the piping for a system of engines and boilers it is evident that the arrangement can be

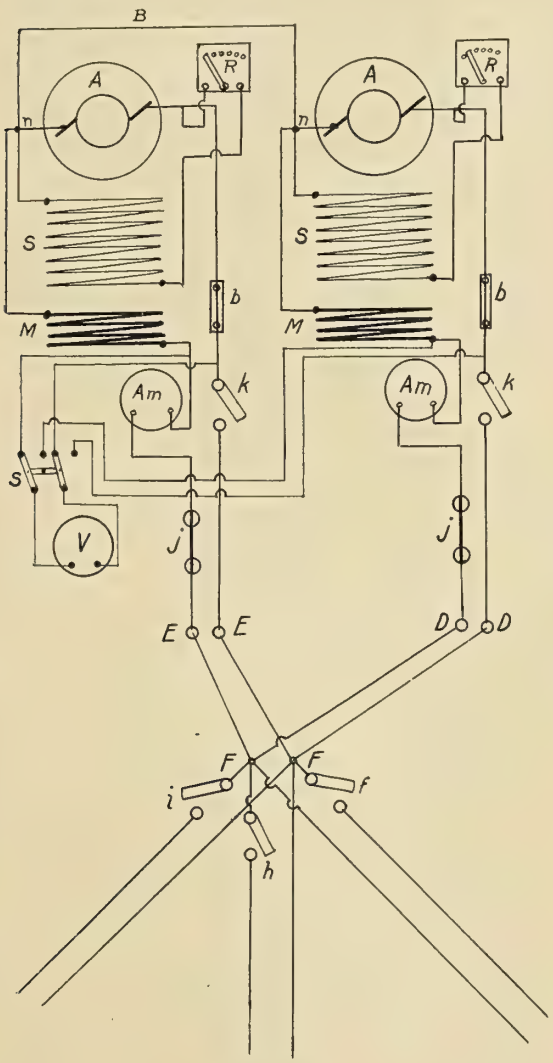


Fig. 62.

made far more convenient if all the switches and other devices are arranged in some kind of a system at one particular point. This at once leads us to the idea of a switch-board, but before proceeding to explain the general arrangement of these it will be necessary to explain the use of the wire *B* shown in Fig. 62. The arrangement of the various wires in this figure is such that the exact relation of *B* cannot very well be made out, it will therefore simplify matters to consider Fig. 63, from which the office of *B* will be fully understood. In this figure let the direction of the current in all the wires be as indicated by the arrow heads, then, if both machines develop the same voltage, the current flowing in *a* will be the same as that in *b*, and that in *c* and *d* will be twice this much. Suppose now that armature *A'* begins to run a trifle faster and in conse-

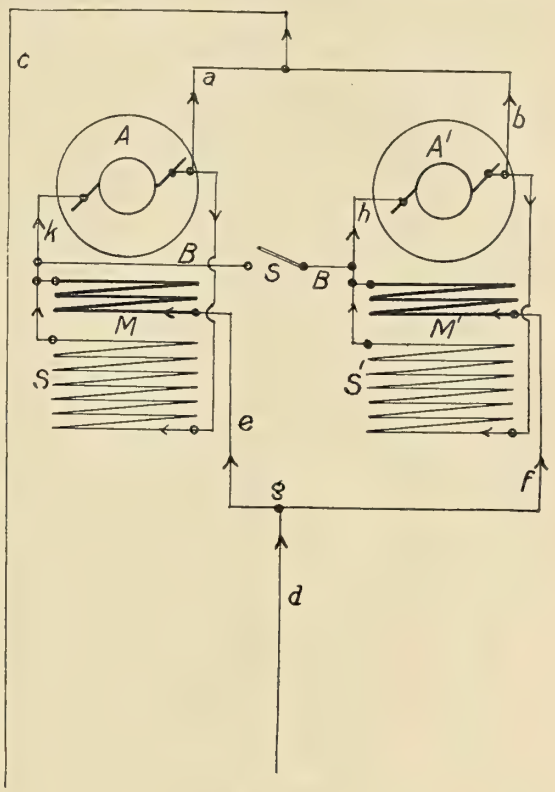


Fig. 63.

quence develops a higher voltage, the result will be that the current in *b* will be greater than that in *a*, and whatever the first gains the second will lose, for the sum of the two must remain equal, since it depends not upon the capacity of the machines to generate current, but upon the demand made by the devices in the external circuit. Suppose the wires *c* and *d* lead to a system of incandescent lamps, numbering say 500. As each lamp requires about one-half of an ampere, the total current would be 250 amperes. With both generators developing the same voltage, the current passing through each armature would then be about 125 amperes. If the current through the armatures is 125, that through the magnetizing coils *M M'* will be nearly as much, being less than that through the armature by the amount that passes through the coils *S S'*, which would be not over two or three amperes. The magnetizing action of the *M* coils is proportional to the strength of the current passing through them; therefore, if the current through armature *A'* increases, that through coil *M'* will increase, and as a consequence the machine will be magnetized more strongly, and this will further increase the voltage, resulting in a further increase of the current. On the other hand, the current in *A* being reduced, the magnetizing action of coil *M* is reduced, and the voltage of *A* is thereby further reduced, which results in a further reduction in the current

through it. Thus we see that a comparatively small initial increase in the current in one of the armatures results in a considerable final increase, because its effect is to cause the voltage to build up in the armature in which the increase takes place and at the same time to reduce in the other one. If the wire *B* is of large size, and as short as the conditions will permit, so as to have a very low resistance, the closing of the switch *s* will have the effect of reducing the difference in the current strength in the two machines to the lowest point. It accomplishes this result in the following manner: Suppose the switch *s* is closed and that armature *A'* begins to develop a greater voltage than *A*, then the current in *A'* will be greater than in *A*, but the currents in the coils *M M'* will be the same, for when the current in wire *d* reaches the point *g* it will meet about the same resistance in passing through wire *F* and coil *M'* to wire *h* as in passing through wire *e* and coil *M* to wire *k*. All the current reaching this last wire will not pass through it to armature *A* because the amount passing through the latter will be governed by the voltage it develops, but as the wire *B* affords a path for the surplus current this will pass by this path to wire *h*.

By resorting to this very simple expedient it will be seen that the difference between the strength of the currents in the two armatures is kept down to a point somewhat lower than that due to the initial difference in the voltage, and this is small compared to the difference developed when the wire *B* is not used. The difference is slightly less than that due to the initial difference in the voltage developed, owing to the fact that in consequence of the presence of the wire *B* the current must divide very nearly equally between the two coils *M* and *M'*, hence the two field magnets remain nearly unchanged in strength. In fact, the only difference in the strength of the field magnets is that due to the fact that a slightly stronger current will flow through *S'* and a slightly weaker one through *S*. If it were not for this difference, which is very small, the change in voltage and current would be no greater than if the fields were kept of constant strength by being magnetized by a uniform current from an independent source.

ENGINEERS' DICTIONARY—IX.

Boiler Mountings.—Various attachments to a boiler, such as steam and water gauges, safety valve, gauge cocks, etc.

Breeching.—A passage or uptake leading the smoke and products of combustion from the front connection of the marine boiler to the funnel or stack. Used also in referring to the sheet metal forming such passage.

Bull-ring.—A heavy continuous ring used in piston packing. In horizontal engines it takes the weight of the piston and in vertical engines keeps it properly centered. In its surface are cut one or more grooves which carry light metallic packing rings of the usual type, and by this means the joint between the piston and cylinder is made steam tight.

Carbonic acid or *Carbon-dioxide.*—In chemical symbols CO_2. The chemical compound formed by the complete union of carbon as in coal with oxygen. It is naturally one of the chief constituents of the gaseous products of combustion.

Carbon-monoxide.—In chemical symbols CO. A product of the union of carbon and oxygen in which less oxygen is absorbed than for the production of CO_2. In other words, it may be considered as partially burnt carbon. If it escapes with the gases of combustion without further combination with oxygen, it occasions a loss of about 70 per cent. of the heating effect of the fuel. Its escape unconsumed is, therefore, the source of a serious loss, and is to be carefully avoided. With the proper supply of air over the fire it readily burns with the peculiar bluish flame commonly seen soon after a fresh firing, and is thus reduced to CO_2, the completely oxidized product of carbon and oxygen.

Calorimeter.—(1) In general a heat measure or an apparatus for measuring quantities of heat. (2) The term is also used to denote the total cross sectional area through the tubes of a boiler, or the area for the passage of the products of combustion. (3) It is also used to denote an apparatus for determining the quality of steam; that is, the percentages in the form of vapor and of liquid. Modern steam calorimeters are of two forms, *separating* and *superheating.* The former consists essentially of a special form of separator which removes from a known or measured amount of steam all the moisture, at least within less than one per cent. The moisture being collected and weighed, and the steam from which it was separated being condensed and weighed, the desired proportions are readily found. In the superheating calorimeter advantage is taken of the fact that when a jet of steam escapes into the air from a much higher pressure, the vaporous portion tends to superheat itself, and this results in a drying of the steam as a whole. By an appropriate measurement of temperatures and pressures the degree of moisture in the steam may be determined. This type of calorimeter is only applicable when the entire amount of moisture is relatively small, for example, not over 3 or 4 per cent. In the *barrel calorimeter*, an older form, the steam to be tested was run into a barrel containing a known amount of water. By measuring the temperatures and amounts of water and steam, the quality could be found by computation.

Calorimeter-ratio.—A term applied to the ratio of the grate-surface of a boiler to the calorimeter or cross-sectional area of the tubes. The value of this ratio is usually from 5 to 8.

Caulking.—In boiler and ship construction, an operation for making riveted joints tight against liquid and vapor. It consists in beating down by means of special tools the edges of the metal against the face of the opposite plate. See Fig. 25. Such tools are known as *caulking irons or tools.* They are of two general types, either square or round nosed, as in the Fig. The latter is usually employed in modern practice.

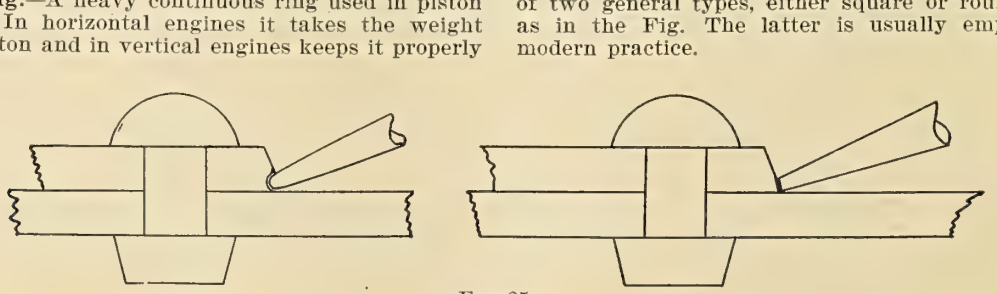


Fig. 25.

Channel-Plate.—A plate or frame in a *channel way* to which the air-pump *foot-valves* are attached.

Channel-way.—In the old form rectangular condenser, a passage leading water from the bottom of the vapor and condensed steam side of the condenser, to the air-pump suction.

Centrifugal Pump.—A form of pump in which the moving part consists of a number of vanes or arms attached to a shaft and revolving within a casing. See Fig. 26. The pump being *primed* or filled with water and started, the rotary motion gives rise to a centrifugal force, in obedience to which the water moves outward toward the tips of the blades, where

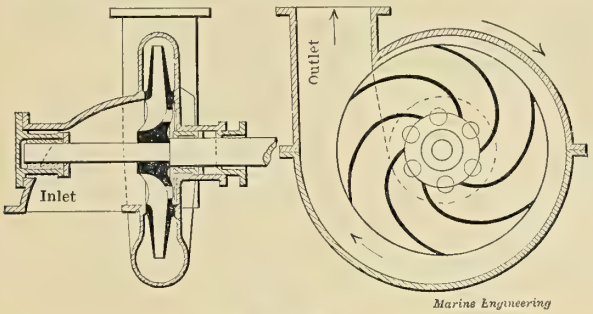


Fig. 26.

it escapes through an opening in the casing into the discharge pipe. Its place is taken by water entering through the suction near the shaft, and thus the operation continues. See also *blower*.

Check-valve or *Feed Check.*—A *self-closing* or *non-return* valve on the feed pipe near the boiler. See Fig. 27. The valve opens upward to an excess of pressure from the feed-pump and allows the entrance

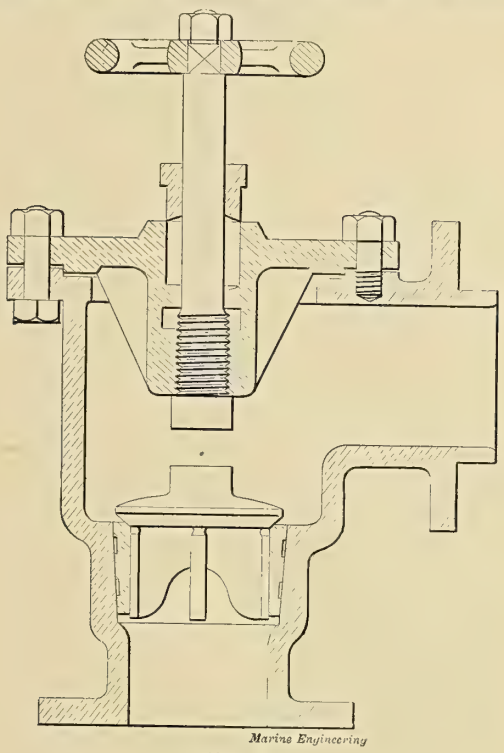


Fig. 27.

of the feed-water, but closes with an excess of pressure from above, and thus prevents the return or loss of the water between the strokes or when the pump is stopped.

Chute or *Shoot.*—A pipe or tube for conveying coal or ashes.

Circulating-Pump.—A pump used to force the water through the tubes of a surface condenser. It is usually of the centrifugal type. See *centrifugal pump*. The amount of water handled is usually from thirty to forty times the amount of steam condensed.

Circulator or *Hydrokineter.*—A device for aiding the circulation in fire-tube or Scotch boilers. The usual form of circulator involves some combination of conical discharge nozzles and passages working in a manner generally similar to the bilge siphon or to the injector. See *bilge siphon*.

Circumferential Joint or **Seam.**—In a cylindrical body, such as a boiler shell, a joint or seam running around the cylinder or in a plane at right angles to the axis.

Clearance.—In general, the least distance between a moving part of a machine and some portion of a relatively stationary part. In particular, the distance between the top or bottom of the piston and the top or bottom cylinder head when the engine is on the top or bottom center. Such distance is usually from 1-4 in. to 3-4 in., varying with the size and style of engine. This distance is also known as the *clearance proper*. The term *clearance* is also used to denote the volume between the face of the piston when at the end of the stroke and the face of the valve or valve seat, expressed as a percentage of the volume displaced by the piston in one stroke. This includes the volume due to the *clearance proper* added to that in the steam passages and ports. In amount it varies in marine engines from 8 to 10 per cent. to 15 or 20 per cent.

Coal.—The principal fuel for engineering purposes. It consists of uncrystallized carbon combined with volatile hydrocarbons and ash or incombustible matter. Hydrocarbons are chemical compounds formed of carbon hydrogen and oxygen in certain proportions. Coal may be roughly divided into two chief varieties, *Anthracite* and *Bituminous*, with intermediate grades, *Semi-anthracite* and *Semi-bituminous*, occupying the general middle ground between the two. In anthracite coal the proportions of volatile matter varies from 3 to 10 per cent; in semi-anthracite and semi-bituminous, from 10 to 20 per cent, and in bituminous, from 20 to 50 per cent. The amount of ash in good coal should not exceed from 10 to 15 per cent, while occasionally it falls as low as 5 per cent. Coal is also graded commercially, according to size, the chief terms being the following, and referring more particularly to anthracite coals: *buckwheat*, *pea*, *chestnut*, *stove*, *egg*, *broken* and *lump*.

Coal Heaver or **Passer.**—One of the engineer's force whose duty it is to bring coal from the bunker to the fireroom floor ready for use by the fireman.

Coaling.—The operation of taking coal on board ship from a lighter or wharf.

Coaling-port.—An opening in the side of a ship to facilitate the operation of coaling.

Collapse.—The failure of a tube or furnace by crushing inward, due to pressure on the outer or con-

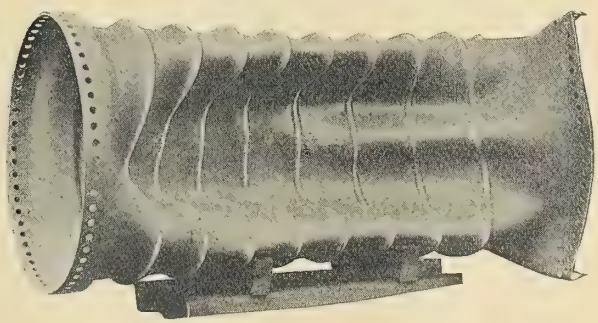


Fig. 28.

vex side. Fig. 28 shows the collapse of a modern furnace of a large marine boiler.

Collar.—A ring on a shaft formed either by forging and turning in place, or as a separate piece secured by pins or bolts. Its office is to prevent end play of the shaft, or to present a bearing surface for taking an end thrust on the shaft. A well known application is the *thrust bearing* of a screw steamer.

QUERIES AND ANSWERS.

Q. How shall I find the displacement of a ship of these dimensions:

Length between perpendiculars...280 ft.
Beam molded ..... 35 ft. 7 in.
Depth of hold ..... 19 ft. 9 in.

We will suppose the ship is drawing 14 ft., even keel. If there is anything else needed, add it, so as to illustrate the question. I only want to find it without a scale. SAN FRANCISCO.

A.—The displacement of a ship cannot be found accurately without a direct computation from the lines. Approximately, however, it may be found from the length, beam and draught by assuming a *block coefficient* or relation between the volume of the ship and that of a rectangular block which would just contain it. The volume of the latter would be the product of the three dimensions, length, beam and draught, and this multiplied by the coefficient assumed gives an approximate value for the volume of the ship. This must then be divided by 35, the number of cubic feet displaced per ton, and the quotient will give an approximate value for the displacement, more or less accurate according to the closeness of the assumed coefficient to its true value. The value of the block coefficient may vary from .35 or .40 to .75 or .80, but for ordinary mercantile ships is usually found between .60 and .70 or .75. Its value varies with the fineness of the ships, both in water-line and in section.

The above operation may be expressed by the following:

Rule—Multiply together the *length*, *beam* and *draught* and the product by the *block coefficient*, and divide by 35. The quotient is the displacement in tons of 2,240 pounds.

$$\text{Or displacement} = \frac{\text{length} \times \text{beam} \times \text{draught} \times \text{block coefficient}}{35}.$$

In the present case, assuming a value of .65, we have:

$$\text{Displacement} = \frac{280 \times 35\,58 \times 14 \times .65}{35} = 2{,}590 \text{ tons.}$$

For other values of the coefficient we should find as follows:

Coefficient.	Displacement.
.60	2,391
.65	2,590
.70	2,789
.75	2,988

Q. What is the difference between pressure and weight? T. M. G.

A.—*Pressure* means always a certain amount of force or load distributed over a certain area, as a pressure of 100 lbs. per sq. in., or a total pressure or load of 120,000 lbs. on a cylinder head, or a pressure of 2 tons per sq. ft., etc.

Weight means always the measure of the attraction of gravitation on a given amount of matter.

Both pressure and weight are, therefore, *force* in their ultimate nature, but their cause and immediate nature may widely differ. In some cases weight and pressure may be numerically the same, the pressure being simply the force due to the attraction of gravitation. Thus when a box is weighed on a platform scale the pressure on the platform is due to gravitation, and is the same as the weight; and in fact the

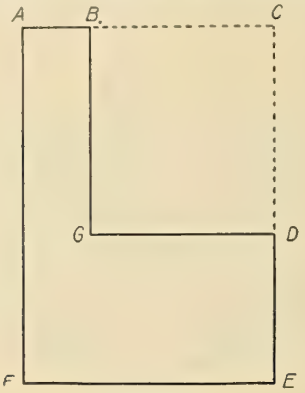


FIG. A.

scale simply measures this pressure transmitted from the box to the platform. In the case of a can of water shaped as in Fig. A we have an illustration of the difference between pressure and weight. The pressure in the liquid depends, as we know, simply on the depth, and therefore on the bottom E F the *pressure* will be uniformly distributed, and the same as though the can were of uniform size A C E F. We know very well, however, that the weight of the water in A B G D E F cannot be as great as in A C E F. How, then, is this extra pressure on the bottom of the can balanced so that when placed on a scale the indication will properly give the weight? The answer is found in the pressure upward on the face G D, which will be that due to the depth B G, and will therefore in amount just equal the weight of the water in the added part B C D G. We have, therefore, a pressure down on the bottom of the can equal to the weight of a volume of water A C E F, and a pressure upward on G D equal to the weight of a volume of water B C D G, and hence a *net* pressure or load transmitted from the can to the scale platform equal to the difference of these, or to the weight of the actual can of water, as desired. Here, then, weight is equal to a difference of pressures. Attention should also be paid to the difference between the pressure on the platform, which equals the weight, and the pressure on the bottom of the can, which, as we have seen, is greater than the weight.

As used by the engineer, the term *pressure* may refer to a force or load on a surface due to an elastic fluid, such as steam or compressed air, or to a force acting between two surfaces, such as the force acting between the slipper and the guides of a steam engine. The term *weight* is always used with its one meaning, as above stated, and, keeping in mind the relation between the two terms as above explained, no trouble should arise in any case likely to present itself to the engineer.

Q. In the dock trial of a ship, why is it that the engines never develop the revolutions nor the power which they would with the same steam pressure in free route; that is, steaming at sea?

FIRST ASSISTANT.

A.—In the issue of Marine Engineering for March last you will find a similar problem discussed, viz.: why, when

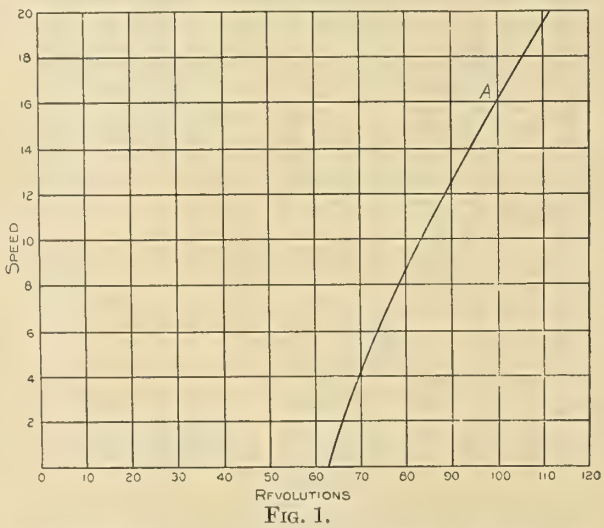


FIG. 1.

one ship is towing another, do the revolutions and power fall off as compared with the same ship running free with the same boiler pressure and cut-off?

Inasmuch as the question of dock trials has an interest and importance of its own, the principles spoken of in the former answer may be here developed somewhat more generally, and extended to the present subject.

Suppose, first, that the ship, boilers, engine and propeller are all properly designed for a certain speed. This means that with a given boiler pressure (say 180 lbs.) the boilers will be able to supply steam enough to drive the engines at the expected number of revolutions (say 100) and thus develop the designed power, while the propeller, with a certain slip (say 20 per cent), will drive the ship at the designed speed (say 16 knots). Now it must first be noted that all of these conditions go together, and if any one of them is disturbed it will react on all the others. The next point is that a constant set of pressures throughout the engine means a constant reduced mean effective pressure, a constant turning moment on the shaft, and a nearly constant thrust, and hence a nearly constant resistance overcome. Now if the resistance at the regular speed is increased, as by taking up a tow, what will be the immediate result? Evidently the speed will decrease until at some reduced speed the nearly constant developed thrust will balance the resistance, and the motion will become uniform again. The greater the increase in resistance at the regular speed, i. e., the larger the tow, the lower the speed at which the nearly constant thrust will be able to balance the resistance and thus produce steady conditions.

The whole question now turns on the *revolutions* at this reduced speed. In other words, how do revolutions and speed vary with constant turning moment and a nearly constant thrust developed or resistance overcome? This is best answered by experimental data, which give us a relation similar to that shown in Fig. 1. Revolutions are laid off horizontally and speed vertically. If we suppose that 100 revolutions and 16 knots are the designed conditions, as indicated by the point A, then the curve shows how the revolutions and speed vary for a nearly constant thrust. In particular the curve shows that as the tow is increased in amount and the speed for a

given thrust constantly decreases, so likewise do the revolutions decrease, though at a relatively slower rate, so that with the decrease of speed the slip constantly increases. Now the relations shown by this curve furnish the key to the whole question regarding the I.H.P.; for since the work done is a product of the revolutions into other factors, and since these other factors include merely dimensions of the engine and mean effective pressure, and since by assumption all of these remain constant, it is evident that under the conditions assumed the power developed will vary directly with the revolutions, and since the latter decrease with decrease in speed, so will the power decrease in like proportion. If we should continue to add to the tow indefinitely we should at length reach a condition similar to that of a vessel tied to a dock: that is, a condition in which the speed has become nothing and the revolutions reduced in marked degree. The exact relation between revolutions in free route and tied to a dock will depend on the special circumstances. The mean effective pressure remains the same, however, and the work done and power developed will therefore be decreased in the same proportion as the revolutions.

To state the thing in one sentence, therefore, the power falls off because the revolutions fall off, and the revolutions fall off because for a given propeller the turning resistance, which a constant pressure in the cylinders can overcome, is reached at a lower and lower value of the revolutions as the speed is made lower and lower.

The reason why of the facts expressed by the curve in Fig. 1, on which the whole explanation really turns, is to be found in the fundamental relation between revolutions, slip, thrust, etc., and a complete discussion of this phase of the question would exceed the proper limits of this reply. Once these relations accepted as experimental truth, however, the desired explanation is seen to flow from them as a necessary consequence.

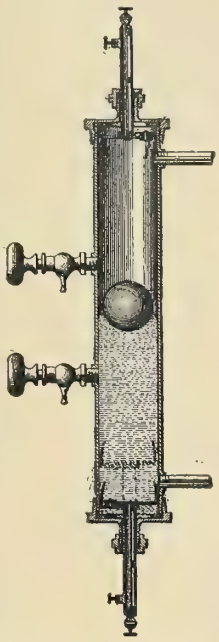
Q. Will you answer this question, which was asked in my examination: Do the crank-pin and piston travel the same distance? GREAT LAKES.

A.—The path of the piston is a straight line, and that of the crank-pin is a circle, whose diameter is equal to the piston travel. So far as their paths are concerned, therefore, they are entirely different in character. The circular path of the crank-pin is, however (with a vertical engine), made up of a vertical motion equal to the piston travel and an equal, horizontal motion, the two combined giving the movement in a circle, as above stated. It is therefore correct to say that, with a vertical engine, the up-and-down motion of the crank, or the vertical part or component of its motion, equals the motion of the piston, and in no other sense can their motions or distances traveled be said to be the same, and similarly with a horizontal engine for the horizontal component of the motion of the crank and the motion of the piston. The ratio between the actual distances traveled, the one in the circular and the other in the straight line path, is, of course, the ratio between the circumference of a circle and its diameter, or 3.1416—the ratio commonly represented by the Greek letter π (called *pi*).

The 1898 Blue Book of American Shipping has been received. It is one-fourth larger than the 1898 edition containing 575 pages, fully one-half of which are devoted to coast information. The selection and accuracy of this information could hardly be excelled were the book published exclusively for coast interests instead of the whole United States. It is really a complete marine directory of the United States, and any one connected in any way with maritime affairs will find it not only useful, but ornamental, as there are over 100 pages of illustrations of numerous coast and ocean steamers, 30 war ships and over 100 portraits of prominent eastern marine business men. One of the most important features is a list of over 6,000 coast and river steamers, including practically all coast vessels over 100 tons. Six thousand masters', mates' and engineers' names and addresses are included, as well as complete directories of the Society of Naval Architects and Marine Engineers, Society of Naval Engineers, the National Board of Steam Navigation, and a directory of departments of the U. S. Government with which marine men have business. There are lists of ship builders and a list of 500 concerns that own 3,000 of the better class of coast vessels. Statistical information of exports by port and commodity for six years past, and tables showing the condition of American shipping, are shown. Lists of 400 ship builders of the world and 1,280 owners of 10,000 of the largest vessels in the world are added. It is of practical use to steamship agents, owners, and everybody engaged in marine business, containing information that is constantly needed. It is published by the Marine Review, Cleveland, O., price $5.

SELECTED PATENTS.

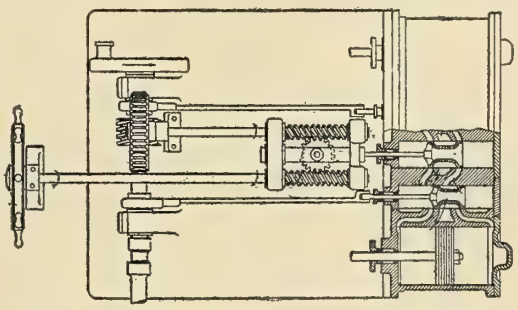
599,220. ELECTRIC-ALARM WATER-COLUMN. *Martin L. Bush, Lawrence, Mass., assignor of one-half to Charles F. Swain, Methuen, Mass. Filed June 14, 1897.*



The combination in an electric-alarm water-cylinder having boiler connections, of a float in the cylinder, a tube and rod connected with cylinder insulated from each other, and carrying arms adapted to be engaged by said float, means for vertically adjusting the arms, and the wires and battery connections whereby the alarm is sounded when the float contacts with the arms.

603,038. STEAM STEERING-GEAR. *William H. Harfield, London, England. Filed October 29, 1897. Patented in England March 22, 1889. No. 5,018.*

In a steam steering-gear, the combination with the engine-cylinder, piston and driving-shaft, of a valve-chamber provided with a steam-inlet and ports communicating with the cylinder on both sides of the piston, of a controlling and reversing valve normally closing the ports, a valve-rod connected to the valve and provided with a worm-wheel, a worm shaft operated by the steering-wheel and provided with a worm engaging the worm-wheel, and a worm-shaft operated by the engine-shaft provided with a worm engaging the worm-wheel for moving said valve back to its normal position. The combination with the engine-cylinder, of a controlling and reversing valve therefor, a valve-rod connected with the valve and provided with a worm-wheel, a worm operated by the steering-wheel, engaging the worm-wheel for moving the valve in either direction, and a worm driven by the engine, engaging the worm-wheel for moving the valve back into its initial position. The

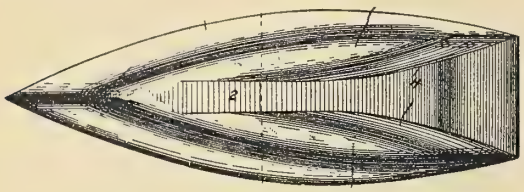


combination with the engine cylinder, piston and driving-shaft, of a controlling and reversing valve, a longitudinally-movally bar connected to the valve, the bar being mounted in stationary guides, and provided with a worm-wheel, a worm engaging the worm-wheel on one side, and operatively connected with the steering wheel, and a worm engaging the worm-wheel on the opposite side and operatively connected with the engine.

597,195. BOAT. *Martin V. B. Evesson, Aransas Pass, Tex. Filed May 28, 1896.*

As an improvement in boat construction, the herein-described hull, the same being grooved centrally along its bottom, from a point just abaft the stem, with the line of the groove gradually rising from said point

to the stern of the boat, thus forming upon each side of the central portion of the hull convex ridges tapering near their rear ends upon curved lines from near the longitudinal center of the hull end extending to



the stern and at a point near the stern inclining upward as they approach the stern, whereby the escape of the water is facilitated and giving greater stability to the boat.

No war, in recent years at any rate, afforded more subject matter for illustrations in technical and popular periodicals than the Spanish-American war. Some of this matter has, of course, been made use of without discrimination, but among popular papers the Navy and Army Illustrated, of London, has taken high place in the reproduction of accurate pictures of both sides. In views of naval ships, both Spanish and American, it has far surpassed its contemporaries, both in variety and in the very important point of accuracy, as most of the views presented were reproductions of actual photographs. We have, indeed, found upon occasion in its pages the only authentic views of various naval subjects and in several instances have reproduced these for the benefit of our readers. The paper is indeed a standard authority in matters pertaining to the British Navy and Army. The half-tone illustrations in each issue are the finest specimens of process work published in the United Kingdom. The paper is edited by Commander Charles N. Robinson, R. N., and is published by the enterprising George Newnes, 12 Southampton street, London, W. C. It is a weekly, and the foreign subscription is 34s. 8d. a year.

A "Master's Manual" for 1898 has been published by the Great Lakes Register, Royal Insurance building, Chicago. It is an exceedingly convenient compilation, including the various rules and regulations, both federal and local, for the navigation of lake waterways, detailed instructions on using the compass and the use of charts, laws affecting citizenship of officers, cases of wreck, the carriage of passengers, life-saving instructions and a chapter explanatory of the weather. This is illustrated with drawings of the various United States signal flags and of the Canadian storm signals. There are a number of sheets of memoranda paper at the back of the book, which contains about 120 pages.

TRADE PUBLICATIONS.

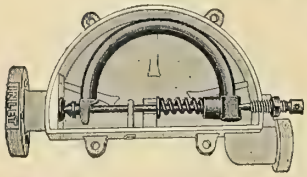
A 50-page catalogue of boats and canoes is received from C. B. Mather & Co., Rowley, Mass. It illustrates a full line of yacht tenders, rowboats, canoes, and, in short, almost everything in the line of small boats. Much valuable information is given which will be appreciated by every user of boats.

A very handsomely printed and completely illustrated catalogue of 80 pages, 6 by 9 in. in size, is issued by the Morse Twist Drill & Machine Co., New Bedford, Mass. It illustrates a full line of twist drills, chucks, reamers, milling cutters, taps and dies, and machine tools. A copy of this catalogue should be in the hands of every user of tools, as frequent reference is made to it in the advertisement of this company which appears in our advertising pages.

Live Steam

costs money. If wasted for want of a good steam trap—means just that much profit actually burned up in your boiler. Prevent it? Of course you can. Use the "Heintz" Steam Trap on all outlets; saves steam, allows no waste of hot water. You can take a "Heintz" on thirty days' trial—or buy one, use it a year and if not satisfied, return the trap—we return your money. Did we ever return it? No, never asked to; but it has been our guarantee, and we are always ready to meet it.

Booklet "G" will tell our story further, and we would like to send you a copy.



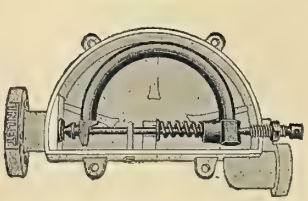
William S. Haines Company,
136 South Fourth Street,
Philadelphia.

"The Heintz—the best—tho' it has imitators."

© COPYRIGHT, 1897, BY THE WHITMAN CO., N. Y. 1

Hot Water

saved with the "Heintz" Steam Trap—puts it where you want it, too. Works in any position—opens and closes on difference of one degree of heat—211° to 212°—smallest size discharges one gallon water a minute and not an ounce of steam wasted. Six parts besides the case—No levers, no floats, no springs. Practically nothing to wear out. Ask for Booklet "G"



William S. Haines Company,
136 South Fourth Street,
Philadelphia.

"The Heintz—the best—tho' it has imitators."

© COPYRIGHT, 1897, BY THE WHITMAN CO., N. Y. 9

Graphite Lubrication

There is no substance known so smooth or so enduring as **Dixon's Pure Flake Graphite.** It is the best solid natural lubricant ever discovered. It is not affected by heat or cold, acids or alkalies. It is absolutely indispensable to every marine, stationary or locomotive engineer.

Largely increases the lubricating value of all oils or greases.

Will cool bearings and stop "groaning" or squeaking when all other lubricants fail.

It will pay you to send for Sample and Pamphlet. No charge.

JOSEPH DIXON CRUCIBLE CO., Jersey City, N.J.

AN OPPORTUNITY FOR MARINE ENGINEERS.

AMERICAN SCHOOL OF CORRESPONDENCE
(Chartered by the Commonwealth of Massachusetts)
Offers a Thorough Course in

MARINE ENGINEERING.

We make a SPECIALTY of teaching Steam, Electrical and Mechanical Engineering.

Our COURSES are thorough and practical.

Our ADVISORY BOARD consists of experts of world-wide fame.

Our INSTRUCTORS are graduates of the best technical schools.

Our TERMS are low and within reach of every wage-earner.

Hundreds of ambitious ENGINEERS, ELECTRICIANS and MECHANICS have secured better positions and larger salaries through the up-to-date technical education received from our school.
We have helped others and we can help YOU.

Special Offer to Readers of "Marine Engineering."

33 1/3% REDUCTION. For another 30 days we will **FOR 30 DAYS.**

continue to offer **33 1/3% REDUCTION** from our regular tuition fee to all readers of MARINE ENGINEERING. Write for our new handbook "N" containing schedules of courses, names of instructors, pages from instruction papers, etc.

AMERICAN SCHOOL OF CORRESPONDENCE,
BOSTON, MASS.

An 8-page folder, descriptive of the Dart patent union coupling and of the patent self-lubricating ball or roller bearing iron cocks, is received. These goods are manufactured by the E. M. Dart Mfg. Co., Providence, R. I. Information regarding them and copies of the folder are sent to all inquiring for them.

Simple and compound engines manufactured by the Cruickshank Engine Co., Providence, R. I., are illustrated and described in a 4-page folder. These engines are built in any size from 3 horse power up, and their special features are well described in the folder.

A series of sheets, illustrating all the types of engines manufactured by W. D. Forbes & Co., Hoboken, N. J., is being issued, and should be in the hands of every man who has to do with engines for propelling purposes or for running electric plants, ventilating fans, etc. The sheets are 6 by 9 in. in size, and on the back of each is detailed description of the engines illustrated. The sheets are designed to form part of a permanent catalogue, which will not be bound, but contained in a strong folder, thus making them convenient for handling and for future reference.

BUSINESS NOTES.

PICTURE OF THE OREGON.—A handsome color picture of the battleship Oregon is sent to all engineers by The Peerless Rubber Mfg. Co., 16 Warren St., New York, upon receipt of five cents in stamps. It is large and suitable for framing.

AN IMMENSE MACHINE.—The Hilles & Jones Co., Wilmington, Del., has recently completed an immense machine for the Harlan & Hollingsworth Co., for rolling and bending ship plates. The machine was of such size that three cars were required to transport it.

ANTI-FOULING PAINT ON THE "FARRAGUT."—The torpedo-boat destroyer Farragut, recently given a test by the Union Iron Works, San Francisco, who built her, was painted with Williams' submarine compound after very exhaustive water tests made of this and other paints. This paint is made by Samuel J. Williams, Produce Exchange, New York.

A NEW POLICE BOAT.—The State of Massachusetts is about to put into commission the new state police boat, "Lexington," built at Essex, Mass., by A. D. Storey. She is 122 ft. long, and is equipped with compound engines of 700 horse power, built by Bertelsen & Peterson, East Boston, Mass., and boilers supplied by the Almy Water Tube Boiler Co., Providence, R. I.

ROD PACKING.—The diagonal rod packing illustrated and briefly described in the advertisement of C. A. Daniel, 409 Market St., Philadelphia, is particularly adapted for almost every use in marine work where packing is used. The cuts well illustrate the manner in which the packing is applied. Samples will be sent to all inquirers who wish to see the manner in which the packing is made.

THE DAIMLER PATENTS.—All the property, including plant, machinery, patents, etc., formerly belonging to the Daimler Motor Co., have been purchased by the Daimler Mfg. Co., Long Island City, N. Y. The business is so favorably known that the new company has already found it necessary to increase its facilities in order to supply the demand for boats and yachts of all kinds as well as for engines.

ASBESTOS AIR CELL FIRE BOARD.—The U. S. Navy is considering the adoption of asbestos air cell fire boards for bulkheads and other purposes on the new vessels to be ordered, for the reason that it is fire proof, water proof, sound proof, vermin proof, very light in weight, yet strong, and will prevent metal from sweating. It is particularly adapted to any use on board a vessel where any of these requirements are called for. Full information regarding this board can be had from the New York Asbestos Co., 287 Douglass St., Broklyn, N. Y.

Shipbuilding Company Incorporated.—Owing to a largely increased business, Captain R. M. Spedden, of Baltimore, has incorporated his shipbuilding business under the name of the Spedden Shipbuilding Co.

Forgings for Japan.—The Bethlehem Iron Co., South Bethlehem, Pa., has been asked to bid on the forgings for the engine and shafting for a torpedo-boat to be built in Japan for the Imperial Japanese Navy. The line of shafts, including the thrust and crank shafts, is to be hollow. It is understood that the Bethlehem Co. is the only concern in this country that has been asked to bid on this work.

Patent Stockless Anchors.—We are informed that the Baldt Anchor Co., Chester, Pa., has just accepted an order for 100,000 lbs. of anchors of their latest improved type for export, which is a high compliment to this company. The Baldt anchors have been approved by the Lloyds, thus giving them commercial standing, and the manufacturers are very busy now, having on hand domestic orders for over 100,000 lbs. of anchors ranging in weight from 20 to 12,000 lbs. These anchors are made of a fine quality of steel of 60,000 lbs. tensile strength, with an elongation of 15 per cent to 25 per cent in 8 in. This company has agencies in New York and in Cleveland, as shown in the advertisement.

Popular Devices.—In a letter to Marine Engineering, H. Bloomsburg & Co., Newport News, Va., say: "We are now furnishing circulators for four boilers and a jet for the donkey stock of a Merchants' & Miners' Transportation Co.'s ship, and have delivered circulators for two boilers for the Chemical Co.'s steamer, both building at Harlan & Hollinsworth Co., Wilmington, Del. We furnished one circulator to Cambell & Zell Co., Baltimore, for P. Dougherty's tug, and have an order from them for another for the tug Confidence for the Boston Towboat Co. We have just shipped one circulator for the steamer Flyer of Seattle, Wash. We have delivered two jets to the Hoboken Ferry Co., 45 in. by 71 in., for the steamers Hamburg and Bremen, and one 54 in. jet to the Neafie & Levy Co.

Howden Draft.—In a letter to the Detroit Dry Dock Co., Mr. A. W. Goodrich, of the Goodrich Transportation Co., wrote as follows regarding the results of the Howden hot draft system on the steamer Virginia: "Since it has been in use we have had steady steam, and burned slack coal, which costs us $1.10 per ton less than the coal we were forced to use before we introduced the Howden system. At the same time we applied the hot draft we also supplied the "Virginia" with new condensing apparatus, which gives a better vacuum than could be got before. Our saving in the price of coal has been 50 per cent. We attribute 33 1-3 per cent of the saving to the Howden system in enabling us to burn a cheaper grade of coal and maintain steady steam. The balance, or 16 2-3 per cent, we credit to the new condensers.

ZINC WHITE FOR MARINE INTERIORS.

In selecting a paint for the interior of a ship, three points require attention: Permanence of color, durability and brightness. Light is of great importance in a passenger steamer, hence light tints are commonly chosen. The permanence of this light color is of equal importance.

A French writer says: "For the painting of internal fittings of ships it is now universally admitted that zinc white is much more lasting than white lead; as the durability of interior painting is always in proportion to the quantity of oil absorbed."

Zinc white carries fully forty per cent of oil to the painted surface, white lead not more than fifteen per cent; the superiority of the former is obvious.

Moreover, zinc white remains unaltered in the presence of the sulphurous gases always present in ships, while all forms of lead rapidly darken in their presence. The tints produced with zinc white are also much more brilliant than those produced with lead, as any one can convince himself by making a sky-blue tint with zinc and Prussian blue, matching it as nearly as possible with white lead and Prussian blue, painting one half of a board with each, and exposing it to the sun-light and weather. The result will convince him that durable tints can be produced only with zinc white.—Adv.

New Jersey Zinc Co.

REDUCING VALVES

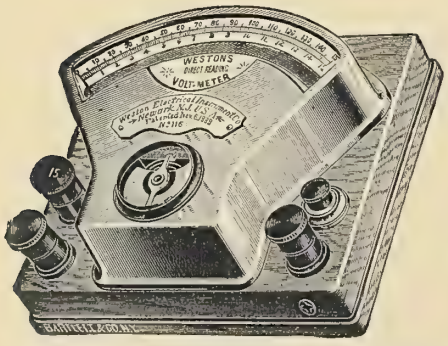
to control or reduce steam, water or air pressures.

"MASON"

Valves have had a world-wide reputation for years.

Write for prices.

THE MASON REGULATOR CO.,
BOSTON, MASS.



Weston Standard Portable Direct Reading Voltmeter.

WESTON STANDARD PORTABLE

DIRECT READING

VOLTMETERS, AMMETERS, MILLIVOLTMETERS, VOLTAMMETERS, MILLIAMMETERS, OHMMETERS, PORTABLE GALVANOMETERS, GROUND DETECTORS AND CIRCUIT TESTERS.

Our Portable Intruments are recognized as THE STANDARD the world over. Our VOLTMETERS and AMMETERS are unsurpassed in point of extreme accuracy and lowest consumption of energy.

WESTON ELECTRICAL INSTRUMENT CO.,
114-120 William St., NEWARK, N. J., U. S. A.

WATERBURY BRASS COMPANY.—The friends of Theo. M. Baker, who has been connected with the copper and brass business for many years, will be interested to learn that he has made a connection with the Waterbury (Conn.) Brass Co. This company is one of the largest producers in the country of seamless brass and copper tubes, brazed tubes, and many other manufactures of brass and copper used in marine work.

BEACON LAMPS.—A recent writer says: "A few weeks ago we had occasion to call attention to the high-grade lamps turned out by the Beacon Lamp Company, New Brunswick, N. J., noting how they retain their initial candle power and high efficiency after a run of 300 hours. The standard efficiency of the lamps is 3.5 watts per candle, and it is an actual fact that after 300 hours' burning the lamps give more light and use less current than when started, and show no blackening."

INSTRUCTION BY CORRESPONDENCE.—Every ambitious engineer should investigate the methods for securing a thorough technical education in his chosen field as offered by the American School of Correspondence of Boston. The school devotes its entire attention to instruction in steam, electrical and mechanical engineering, the instructors in these special courses having been chosen from among the best technical schools of the country. They include such well-known authorities as Dr. Robert Grimshaw, George L. Fowler, Francis V. Boyer, Charles Thorn and other experts on the Advisory Board. The courses are thoroughly up to date and comprehensive; the instruction is simple, practical and scientific, and is so arranged that it can be worked out during leisure moments at home. The school is chartered by the Commonwealth of Massachusetts, and as it is a purely educational institution, and not a money-making enterprise, the tuition fee has been placed within reach of the poorest paid mechanic. The school has a large enrollment, and is endorsed by leading educators and engineers. Handbook will be sent on request.

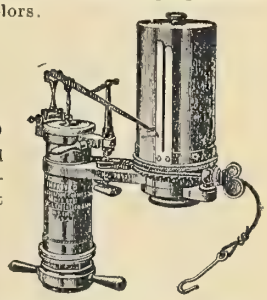
SEND 2 LABELS

cut from front of boxes of EUREKA PACKING and we will send you a pack of beautiful playing cards. All being special in 3 colors.

MARINE ENGINEERS

should own an INDICATOR and know how to use it. Send for circular and *special* prices. It will interest you.

Jas. L. Robertson & Son,
218 Fulton St., N. Y.



SPECIAL NOTICES.

Announcements under this heading will be inserted at the uniform rate of thirty-three-and-a-third cents a line. Lines average ten words each.

BOAT BUILDER WANTED.

I have one of the best equipped boat building yards and plants in the country, for wooden and steel hulls, oil and steam engines; fine frontage on the Delaware river, convenient to Philadelphia; best kind of an opening for an experienced man who can command business. Address, with full particulars, Boat Builder, care of Marine Engineering.

PROFESSIONAL CARD.

H. B. ROELKER,

CONSULTING AND CONSTRUCTING ENGINEER.
Manufacturer of **Screw Propellers** for Usual and for Special Work.
The Allen Dense Air Ice Machine for Steam Vessels.
41 MAIDEN LANE, NEW YORK.

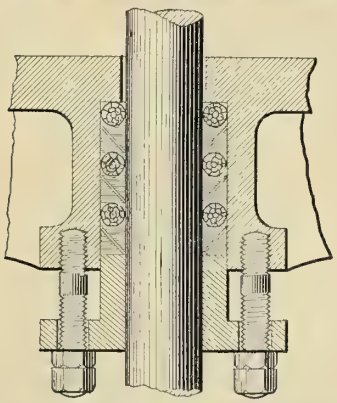


Fig. 1—Packing in position and gland adjusted

DANIEL'S PATENT P. P. P.

Diagonal Rod Packing.

The most elastic and durable packing for feed pumps, air pumps, hydraulic pumps, and trunk plunger pumps, also for electric engines and all other auxiliary engines and pumps. Special grades for high steam pressures on main engine rods and valve stems, also for ammonia compression pump rods.

Send for sample. Will not score the rods. Manufactured only by

C. A. DANIEL,

409 Market St., Philadelphia, Pa.

Branch Offices: Pittsburg, 105 Water St.; San Francisco, 514 Mission St.; Chicago, 4 S. Canal St.; Toledo, 638 Leonard St.

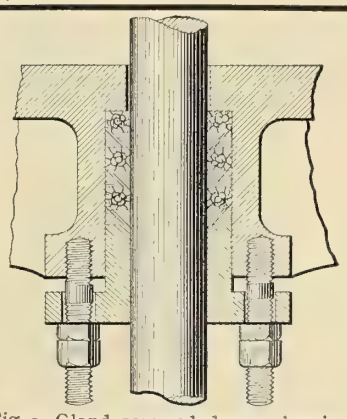
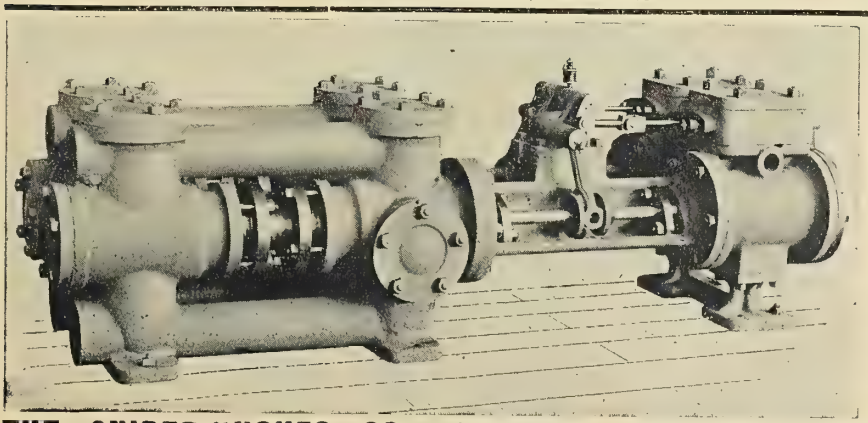


Fig. 2—Gland screwed down, showing how the wedges slide up to compensate for wear.



THE HUGHES IMPROVED DUPLEX PLUNGER PUMPS

Are extra strong, compact and durable. They are externally packed and are particularly well adapted for marine service. Catalogue showing different styles will be sent on application.

THE SNIDER-HUGHES CO., COE AND HAMILTON STREETS, CLEVELAND, O.